Contents

1 Introduction – history and systems

Goats are known as the poor man's cow because of their ability to provide sufficient meat, milk, skins and fibre for the smallholder or subsistence farmer's own use, with perhaps a little left for sale.

This association with poor or small farmers has often meant that goats, as farm animals, have been neglected by those involved in research or development in both tropical and temperate countries. This situation is slowly changing, but the importance of the goat to farming is likely to remain understated and its potential underdeveloped. This book will, it is hoped, encourage more people to recognise the crucial role that this animal could play in the farming systems in which many of the poorest in the world are, or could be, engaged.

There are several good reasons why goats should be kept, even in preference to larger animals such as cattle. These include:

- their low purchase price;
- goats reproduce at an early age and have more young than cattle;
- they produce manageable amounts of meat, milk, skins and fibre for sale or family consumption;
- they have an ability to survive on low quality foods or in difficult conditions on relatively small amounts of food;
- they reduce risks of losses to owners by being cheaper to replace; and
- they are more readily available.

Five goats are considered to be equivalent to one cow or buffalo and so their price is normally low enough for many more farmers to be able to afford to buy several goats. Females can, under good conditions, produce young within 18 months of birth and then a kid every eight months, with multiple births being very common. As a number of goats are usually kept, farmers can easily sell or eat one without affecting their flock size too much. The amount of milk, meat, skins or fibre one goat produces is a convenient quantity for a family to consume where long-term storage is impossible, as is the case in most tropical situations. Milk

is produced in amounts a family can drink, and slaughtering a goat gives enough meat for a feast, wedding or special visitor to consume in one go.

With larger numbers of smaller animals rather than one or two larger ruminants, the risks of losses faced by a farmer from disease, theft or from predators is reduced. With a 20 per cent death rate a farmer with five goats will still have four animals, whereas a farmer with one cow is likely to be left with nothing.

Subsistence farmers keeping goats or sheep need very small amounts of purchased animal food because their stock can manage on very poor quality roughage if required. This is, therefore, a very efficient way of converting roadside verges or crop stubble into valuable products at minimal cost.

1 *Origins and history*

Goats and sheep are small ruminants and belong to the same tribe, called Caprini. This tribe is divided into two parts or genera, *Capra* and *Hemitragus*. The *Hemitragus*, also called Tahrs, are wild goats found in Arabia, the Himalayas and South India. They have short stout horns, no beards, and long shaggy coats. They have only 48 chromosomes in their cells and do not crossbreed with the *Capra*, which has 60.

The domesticated goat originates from the *Capra* genus and this includes five groups or species:

Capra hircus (Bezoar)	W. Asia
Capra ibex (Ibex)	Central Asia, Near East, Alps
Capra caucassica (Tur)	W. Caucasia
Capra pyrenaica (Spanish Ibex)	Pyrenees
Capra falconeri (Markhor)	Afghanistan/Pakistan

The Bezoar is thought to be the main ancestor of today's domesticated goat, but the Markhor has had a strong influence in Central Asia where many goats show the long coarse hair and scimitar type horns which are characteristic of both species. The influence of the Ibex is seen in the prominent 'Roman' nose of breeds such as the Nubian, Jamnapari and Beetal.

Distinguishing the origin of goats is not an easy task. It is physically difficult to tell a goat from a sheep. The most effective and simple way is to look at the tail. In good health and not under stress, a goat's tail points upwards, that of a sheep hangs down. Goats can also have beards and the males have tail glands, which sheep do not.

Horn shapes and hair or fibre covering may help classify goats, but this can be an unreliable method (Fig 1.1).

Goats were probably the first ruminant animal to be domesticated, some 8000 years ago. This occurred in the ancient civilizations along the rivers of the Nile (Africa), Tigris and Euphrates (Asia), and Indus (India). When populations migrated from these areas the domesticated goat spread throughout the continents, most recently to Europe and the Americas.

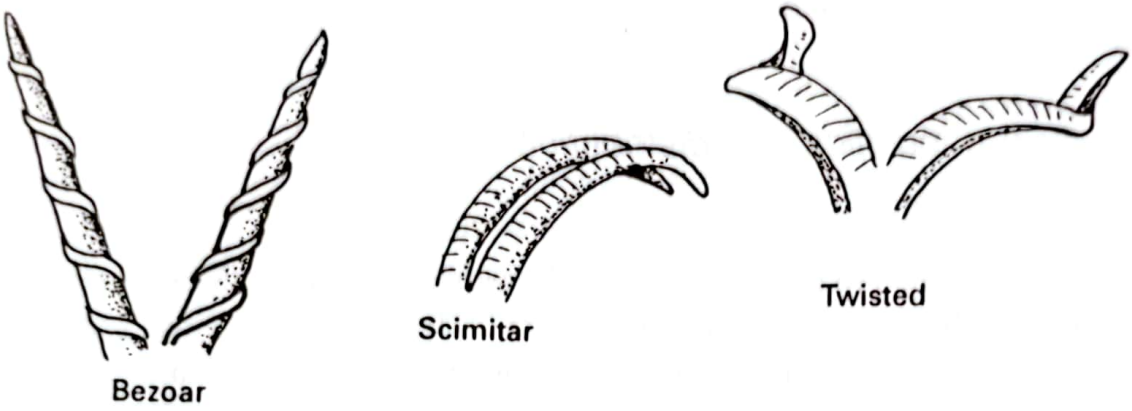


Fig 1.1 *Horn types*

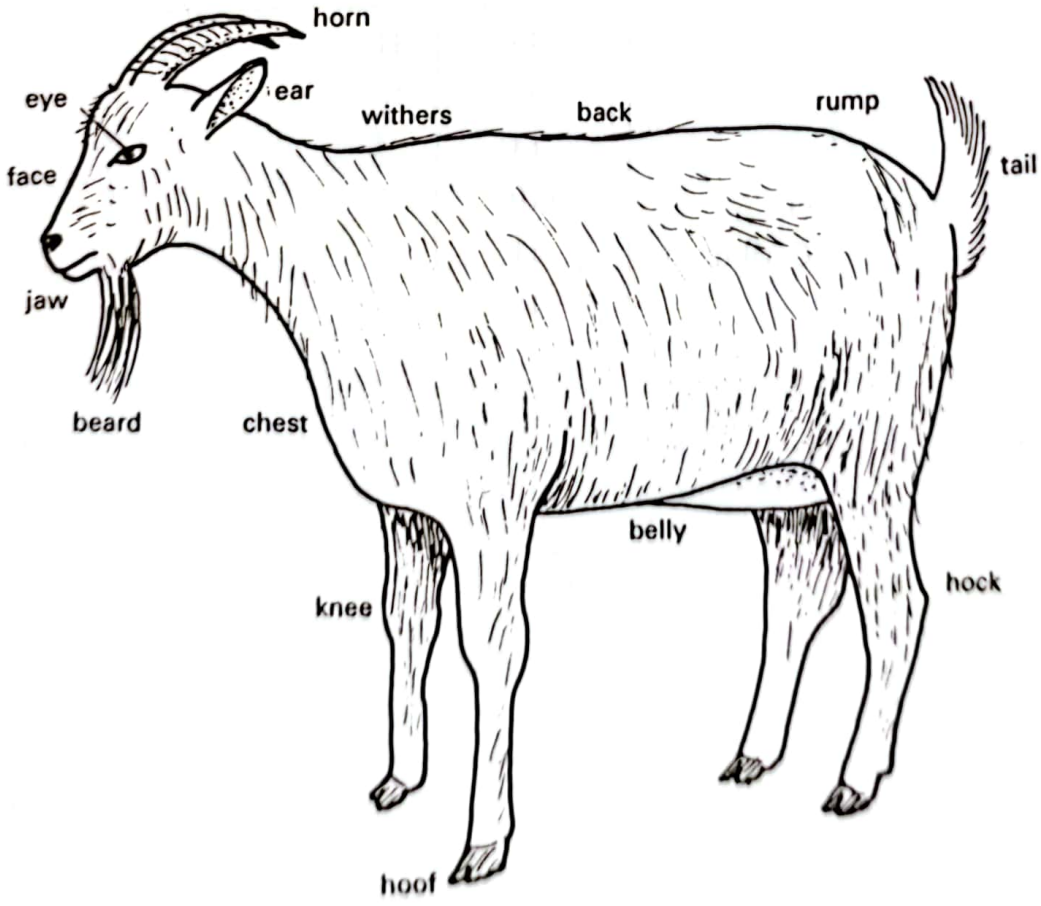


Fig 1.2 *Body parts of a goat*

Table 1.1 Descriptions of goats

Nanny/Doe	Female goat that has kidded
Billy/Buck	Mature male that is used in mating
Billy kid	Young male 0 – 12 months
Nanny kid	Young female 0 – 12 months
Goatling	Female goat which has not yet kidded, up to 2 years old
Yearling	Male or female 1 – 2 years old

2 *Goat population and distribution*

2.1 Population

There are some 446 million goats in the world, of which 351 million are found in the tropics and sub-tropics. This compares with world populations of 470 million for sheep and 563 million for cattle. All of these figures are estimated.

Table 1.2 Goat population of the tropics and sub-tropics

	Millions	%
Africa	145	41
W. Asia	53	15
S.E. Asia	14	4
Indian sub-continent	110	32
Central America/Caribbean	11	3
S. America	18	5

The largest populations of goats are found in Africa and on the Indian sub-continent. Of the ruminant animals in the tropics, 20 per cent are goats. It is also known that the population of goats has been growing at a faster rate than other ruminants.

2.2 Distribution

Goats are found in all types of environments, from arid to humid zones. They do very well in the drier tropics, where their ability to withstand dehydration and their browsing habit enable them to survive where cattle or sheep cannot. This means that they can exist in fragile eco-systems such as the Sahel where, consequently, they are often blamed, sometimes unfairly, for degrading the natural resource base.

3 Goat production systems

A number of different systems of goat production exist, including subsistence, extensive and intensive. The number of goats kept is often a helpful factor that indicates the type of system.

2.1 Subsistence

Subsistence farmers usually keep small numbers of animals and manage to use whatever feed resources are available at village level. This may involve feeding crop or household residues to stall-fed goats, tethering individual animals to verges or allowing goats to scavenge.

Tethering is common in parts of S.E. Asia, S. America and the Caribbean where crops are grown and the goats must be prevented from damaging food or cash crops. Goats are tied with ropes or chains to pegs, trees or posts to constrain their movement. They are moved to a fresh area of grazing once the current patch is eaten down. Supplementary feeding with crop residues or household waste may be given, but not usually concentrates. Water is provided at night, when the goat is returned to its home. Goats may be tethered in small groups or even led by ropes held by children or women.

In the Middle East, where there is little groundcover for goats to graze, especially in the summer, small groups of goats owned by farmers growing dates and catching fish are kept in tiny shaded corrals (Fig 1.3). There they exist on a combination of cut grass and legumes and leftovers from the house meals.

Fig 1.3 *Goats in a corral*

Fig 1.4 *Scavenging goats*

Also in the same region are to be found small flocks of scavenging goats that, during daylight hours, forage in dustbins, on rubbish dumps, in urban building sites, unguarded gardens and on low-growing trees (Fig 1.4). Only at night do they make their own way back to their owner's home.

3.2 Extensive

Under extensive production systems, goats graze and browse large areas of land that are usually of a marginal nature, and unsuitable for other agricultural use. This is usually because rainfall is low or unreliable.

Fig 1.5 *Grazing goats in Kenya*

Goats can make good use of these areas provided the number of animals is controlled to match the **carrying capacity** of the land. The carrying capacity is the amount of forage available to sustain a set number of animals in a given area. The size of flocks within this system is often large, and other species, such as sheep, may also be grazed at the same time.

Under sedentary systems the grazing available to a flock is limited by the distance it can travel daily to reach water, shelter at night and the pastures themselves. A sedentary system is one with a fixed homestead and set grazing area (Fig 1.5).

Some flocks may be moved to grazing areas in different parts of the country to utilise seasonal grazing or crop residues that are available only for limited periods of the year. This is a migratory system which in some parts of the tropics has developed over many centuries to become a very efficient way of using marginal agricultural lands.

In parts of Africa, Asia and India there are two traditional systems of extensive production which have utilised marginal areas very successfully over long periods. These are **nomadism** and **transhumance**. Nomadism was widespread in the Sahel region of Africa and in the Middle and Near East but it is now becoming less common. Nomads have camps which they move depending upon the amount of water and pasture available within an area. As traditional livestock keepers they follow set routes within what are considered tribal lands. These lands often ignore modern-day national boundaries.

Transhumance involves the movement of flocks between permanent settlements and temporary and seasonal pastures as well as between different regional areas. In Europe the flocks are kept in the lower plains during a winter period and moved to higher mountainous areas when the climate is warm enough to allow vegetation to grow and be accessed. Apart from altitude, transhumance also occurs between different areas with the change of seasons, as in the north-south movement in the Sahel.

Transhumance is found in Africa, S.E. Asia, the Near and Middle East and also in Mediterranean Europe and S. America. Animals from different families may be grouped together for the summer as one large flock and goatkeepers may be hired if the families have other duties. Goats are often moved to pastures at higher altitudes than cattle because they are more agile and can better use the sparser vegetation that grows at these heights.

3.3 Intensive

Intensive systems of goat production are those where the goats are confined and so not allowed to forage for themselves (Fig 1.6). In Oman large numbers of goats are reared for meat production in small groups

Fig 1.6 *Intensive goat rearing in Brazil*

of 10 or 15 animals of similar ages and separated into males and females. Two hundred goats may be kept on 1ha of land with no access to grazing. These feed lots or zero grazing systems involve feeding cut grasses (Rhodes, Buffel, Signal) and cut legumes (Lucerne, Siratro, Stylos) as well as concentrates, minerals and vitamins.

Other systems may include grazing improved pastures where fertilisers may be used to boost yields, supplementary feeding of agricultural by-products and supervised grazing of animals on limited areas. In South India and parts of S.E. Asia stall feeding of goats in crop growing areas is a very efficient method of converting poor value crop residues and tree leaves into useful food products for humans. It also avoids damage by the goats to growing crops.

Most intensive management involves high costs resulting from high labour costs, expensive feed, or a large investment in one of the inputs such as land or animals. It may be a combination of several factors. To make these systems successful a high output must be achieved and/or there must be a high priced product.

Keeping numbers of goats confined in a limited area requires meticulous health care if disease, and particularly parasite problems, are to be avoided. Care must also be taken to see that all animals are properly fed, have access to clean water and are regularly cleaned out.

Many methods of goat keeping combine the different systems of management as described here. It is, for example, common in parts of Africa to use children, on returning from school, to shepherd goats that are confined to stalls during the day.

2 Breeds

1 *Introduction*

There are some 300 breeds of goats, many of them located in the tropics and sub-tropics. They have developed not only in response to particular environments but also because man has selected animals for specific characteristics. These characteristics include temperament, productivity and ease of management. There has also been a great deal of crossing between breeds to produce animals that have the characteristics of more than one breed. A breed is a group of goats that can be distinguished from other groups by characteristics that are genetically controlled. Goat breeds are not well recorded in the tropics and are often defined only by the geographical area in which they live. Some breeds, however, are now found in many parts of the world. These include the Angora, Kashmir, Nubian and Saanen.

Goats can be characterised by:

- origin
- function
  milk, meat, fibre
- appearance
  ear shape and length
  body size
  height (goats are normally measured at the withers)
  colour
  horned or polled
  shape of face
  horn shape.

No one particular method of identification is satisfactory when taken by itself. In the following pages goat breeds are presented by region. Details of some of the most interesting and important breeds within each category are also given.

Goats came into Africa when nomadic tribes travelled there from Asia. These goats are characterised by scimitar-shaped horns, erect ears and a beardless face. Most African goats now living on the continent are descended from ancestors that arrived there several thousand years ago. The last 150 years have also seen the introduction of a number of different breeds, for instance the Angora, which have had a considerable impact on local goat populations (Fig 2.1).

It is possible to relate different types of goats to different areas of the continent. Dwarf goats, with their tolerance of trypanosomiasis, are found predominantly in the humid west and centre. Small or medium-sized goats predominate in the east, while large goats are found in southern Africa and along the northern and southern borders of the Sahara.

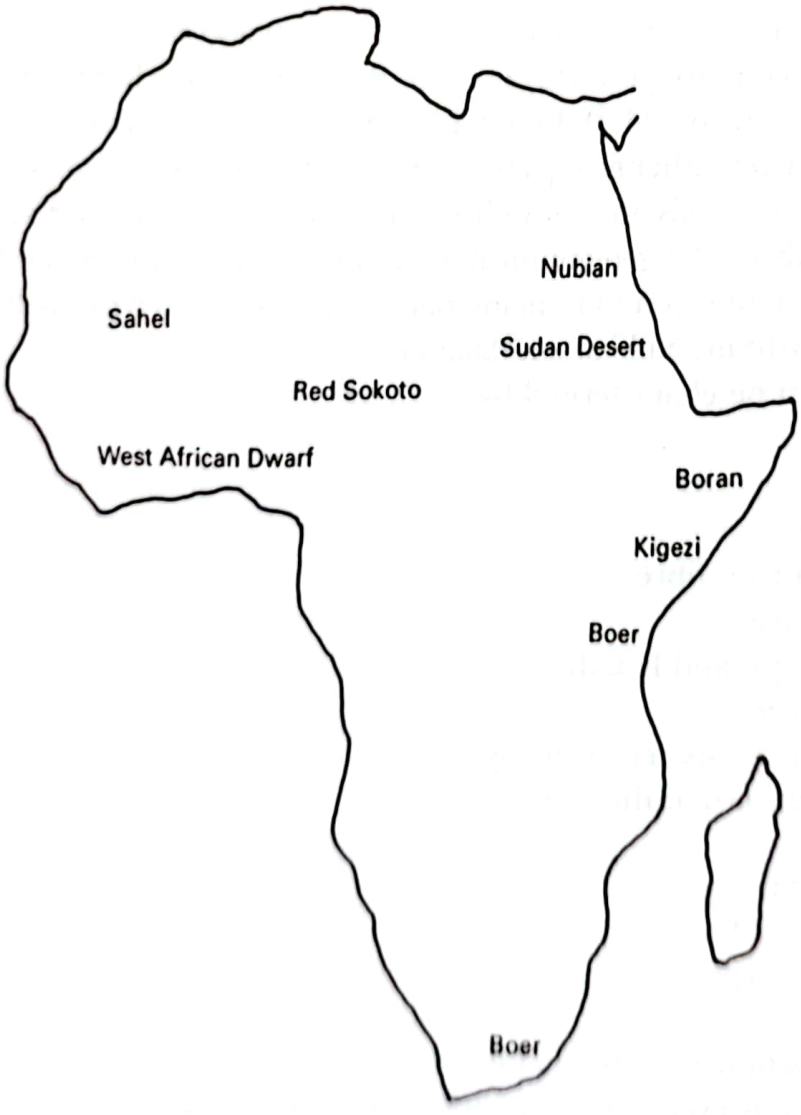


Fig 2.1 *Africa, showing distribution of different breeds of goat*

Table 2.1 Breeds in Africa

Breed type	Location	Height(cm) at withers	Function
Large goats			
Benadir	S. Somalia	70–78	Meat
Boer	S. and E. Africa	75–80	Meat
Landim	Mozambique	65	Meat
Maabite	Algeria	70–83	Milk
Mudugh	N. Somalia	65–75	Meat
Sahel (Long legged)	W. Africa	70–85	Meat and milk
Sudan Desert	Sudan	65–80	Meat
Sudanese Nubian	N. Sudan	71–80	Milk
Sukria	W. Ethiopia	70–85	Milk
Tswana	S. Africa	60–75	Meat
Small/Medium goats			
Angora	S. Africa	61–65	Fibre
Boran	E. Africa	60	Meat
Kigezi	Uganda	65	Meat and hair
Maradi (Red Sokoto)	Niger, N. Nigeria	62–72	Meat and skins
Masai	E. Africa	64	Meat
Somali	Somalia	62	Milk
Dwarf goats			
Congo Dwarf	Uganda, Zaire	45–50	Meat
E. African	E. Africa	50	Meat
Kosi	Cameroon	45–50	Meat
S. Sudan	Sudan	40–50	Meat
W. African Dwarf	Ghana, W. Africa	40–50	Meat

2.1 Large goats in Africa

These are goats that normally stand over 65cm at the withers and weigh between 20 and 63kg when adult.

Boer

This breed originated in S. Africa and has been exported to other African countries and Europe. The breed was developed and improved in S. Africa from what was originally a cross between animals from Holland and India and local Bantu goats. They are large (75–80cm) and heavy, with males weighing 130kg and females 80kg. The main colour is white, with red on the shoulders and head. The animals have a short-haired coat. The modern Boer goat has prominent horns and broad drooping ears.

The breed is used mainly for meat, but milk and skins are also important. Skins are used for shoes and handbags. This is a very fertile goat: over 50 per cent of births are twins, giving an average litter size of 1.64. Kids weigh 3–5kg at birth and can reach 40–50kg by six months of age when fed concentrates. Females can produce 160 litres of milk over 120 days with a butterfat content of 5.7 per cent. Carcass yield is 48–60 per cent.

Sahel (W. African longlegged)

This is also known as the Arab goat in Chad and the Maure in Mauritania. It is similar to other breeds in N. Africa, being very longlegged (70–85cm), and is found in the semi-arid areas in the north of W. Africa. Many goats are kept by pastoralists in mixed flocks with sheep. Not being trypano-tolerant the breed does not survive in forest and dense savanna, where the tsetse fly, the carrier of trypanosomiasis, is found.

Males weigh 40kg and females 27kg when mature. They have small triangular heads, usually with horns. Their coats are short and very fine.

Sahel goats are primarily kept for their meat, and little milk (under 80 litres/lactation) is produced. Around 40 per cent of births give twins, and under pastoral conditions the kids grow very slowly. A carcass dressing percentage of 48–50 per cent is common.

Adult goats, like many desert breeds, have the ability to maintain their weight over long periods whatever the conditions.

Sudan Desert

These goats are found in the area covered by east Chad, north Sudan, and Eritrea. This breed is similar to the Sahel, having many of the characteristics of desert goats, including long legs (65–85cm), a fine coat and tolerance of arid conditions. Colours are mixed, ranging from white, grey and fawn to red and black. White and black stripes are common. Many males have bushy beards and some have manes. Both sexes have horns and lop ears which grow upwards and backwards and can be up to 35cm long in males. Males grow to 38kg and females to 33kg.

Fertility is good with an average litter size of 1.5. Most goats are kept in large flocks shared by agro-pastoralists or nomads but they are individually owned with about 20 animals to each person. Flock populations are normally predominantly female, with under 25 per cent being males in any age group.

Goats of this breed grow well and, as primarily meat animals, dress out at 46–50 per cent.

Sudanese Nubian (Shukria in Eritrea)

This breed is closely related to the Damascus and Syrian Mountain goats and is found in north Sudan, Egypt and Eritrea. Most animals belong to

urban dwellers and are kept in small flocks (2–10 animals) which are allowed to scavenge freely in the day and are confined at night and fed on household wastes. The animals measure up to 85cm in height with males weighing 60kg and females 50kg. The ears of the Nubian are a distinctive feature: they are 25cm long, broad and with the bottom third turning upwards. When grazing the ears trail on the ground. The normal colour of the goat is black, with grey or specked ears. A knot of hair on the head is common.

The breed is prolific, giving a mean litter size of 1.4. Growth of 70–90g per day is achieved in young animals. Lactation yields vary, but 1.5 litres per day is possible with a 3 per cent butterfat. Kids are traditionally prevented from suckling by tying a bag over the udder of the dam.

The Anglo-Nubian stems from the original African Sudanese Nubian breed, which makes the Nubian the only true African milking breed. Because of its production potential and ability to tolerate difficult climates, the Anglo-Nubian has been a popular import into areas that include S. and E. Africa, the W. Indies and Madagascar.

2.2 Small to medium goats (East African) (Fig 2.2)

These are goats that are 51–65cm high at the withers and weigh 19–37kg.

Boran (Galla or Somali)

This breed is found in the semi-arid parts of E. Africa, particularly northern Kenya, southern Somalia and Ethiopia, where it is kept by pastoralists and agriculturalists. Under Somali pastoral systems goats are separated from their kids, which are allowed to suckle only twice daily, after milk for human consumption has been removed from the udder.

Fig 2.2 *East African goats*

The latter can be around 0.5 litres per day. Goats graze on low open thorn bushes during the day but are kept in thorn enclosures at night. Bucks are run with the flock all year round. These flocks are made up of 50–200 individual animals of all ages.

Males can grow to 40kg and females to 30kg. Both have short, pricked ears and small horns. The goats are slightly higher at the girth than at the withers. The colour is usually white with black head markings and a black dorsal stripe. Coats are smooth, short and shiny.

As a meat goat growth is good and a large number of live animals have traditionally been exported. For a tropical breed the Boran starts breeding relatively late, at about 30 months. Twins are common.

Kigezi

The Kigezi breed is common in south-west Uganda, Zaire and Rwanda. It is kept by the Bakiga tribe who are agro-pasturalists or farmers. The animals are kept for their meat and hair. The latter is made into local cloth. Colours are normally black or grey with long hair and horns. Goats grow to 30kg.

Maradi (Red Sokoto)

This distinctive red-coloured goat (Fig 2.3) lives in Nigeria and Niger, where it is kept in small flocks by Hansa-speaking tribes. Animals are confined away from growing crops and may be stall fed. The breed is well adapted to arid conditions and grows to 25kg for females and 27kg for males. Both sexes have scimitar-shaped horns and males have beards.

Because of the importance of the breed for their skins, the ratio of males to females in flocks is higher than in many other breeds. The skins are of the highest quality in the tannery trade and are known as Morocco. Their ease of tanning makes them very popular for shoes and gloves.

Twinning is very common and a litter size of 1.8 is the average. Milk yields of 0.5–1.0 litres per day have been recorded on experimental stations over three-month periods. Nannies with twins outyield those with singles by some 20 per cent. When killed for meat the carcass yield is 45–50 per cent of liveweight.

2.3 Dwarf breeds

These breeds are very short legged and measure 50cm or less in height. They are usually also in the 18–25kg weight range. Dwarfs can be proportionately small all over or just short in the leg.

West African Dwarf (Fouta Djallon, Nigerian Dwarf, Kirdi)

This dwarf breed (Fig 2.4) is found in west and central Africa, along the

Fig 2.3 Left *Red Sokoto goat*
Fig 2.4 Right *West African Dwarf goat*

Atlantic coast. It is trypanosome tolerant and is adapted to the humid forest zone. Goats are kept in small groups and left to roam about homesteads as scavengers. In Nigeria few bucks are kept. In Senegal flocks are owned by women and numbers rarely exceed five. When crops are growing goats will be tethered.

Bucks weigh 25kg and nannies 22kg when mature. Their height is 30–50cm. Both sexes have horns and toggles whilst bucks have beards. Colours vary from dark brown to white and red. Twinning is very common, so average litter sizes range from 1.4 to 1.85. Milk yields reach 0.3 litres per day.

3 *Goats in Asia*

Many of the domestic goats of W. Asia (Middle East, Iraq) originate from *Capra ibex* and show the distinctive characteristics of long lop ears, spiral horns and long black coats. In Asia Minor coarse-haired goats like the Angora are kept for their valuable mohair. Related medium-sized goats are also found in the desert and semi-arid lands between the Gobi desert and the Caspian Sea. These include the Don, Kashmir and Mongolian. Temperatures here range annually from very hot to very cold.

On the Indian sub-continent most domesticated goats show the features of their Markor or Bezoar ancestors. The twisted horns are very distinctive. Black is the dominant colour. North-east India has large populations of goats in the mountains, including Baluchistan and Kashmir, as well as on the Punjab.

In Pakistan most goats live in the drier rangelands, whilst in Bangladesh the cities of Dacca and Rajahahu have large populations of goats.

3.1 Large breeds (over 65cm)

Barbari

This is a popular milking goat from the north of India and Pakistan (Fig 2.5). Despite a small height, daily milk yields of 1.0 litres are reached (0.65 litres/day over 118 days). Adult bucks weigh 40kg and nannies 35kg. Many goats are stall fed and so are well suited for urban and cropping areas. Meat quality is good and the breed is very prolific, with females producing three sets of kids every two years. Colours vary but white with red spots is typical.

Beetal

This is a small version of the Jamnapari with typical Roman nose and long ears. It is very popular in India (Punjab), Pakistan (Rawalpindi) and in Bangladesh. Bucks reach 65kg and nannies 45kg. Males have bushy beards and spirally twisted horns. Females produce up to 1.0 litres milk/day.

Damascus (Shami)

The Damascus is the most important indigenous dairy breed in the Middle East. Milk yields of 2–4 litres/day are common, with a butterfat content of 4 per cent. It is also very prolific and average litters of 1.76 are recorded. The breed shares common ancestors with the Nubian which it resembles. It thus has lop ears and a convex head profile without horns. Colours are usually red or red and white. Females can weigh 60kg.

Fig 2.5 *Barbari goats at Hyderabad, India*

Table 2.2 Breeds in Asia

Breed type	Location	Height(cm) at withers	Function
Large breeds			
Barbari	N. India, Pakistan	60–76	Milk
Beetal	India, Pakistan	84–89	Milk
Chapper	Cyprus, Turkey	60–70	Meat
Damascus/Shami	Near East	73–76	Milk
Dera Din Panah	Pakistan	65–80	Milk
Gaddi	India, Pakistan	80–86	Meat
Jamnapari	N. and Central India	78–100	Milk
Kashmiri/Cashmere	Kashmir, India	65–80	Pashmina/Fibre
Maltese	E. Mediteranean	65–75	Milk
Malabar	S. India	65–80	Milk
Syrian	E. Mediteranean	69–80	Meat
Small breeds			
Anatolian Black	Turkey	55–65	Milk
Angora	Turkey	56–60	Hair
Kilis	Turkey	60–65	Milk
Ganjam	India	55–65	Meat
Kaghani	Pakistan	60–65	Meat
Katjang	Malaysia, Indonesia	50–65	Meat
Ma T'ou	China	45–65	Meat/Milk
Marwani	India	55–65	Meat
Sirohi	Gujarat, India	55–65	Meat
Dwarf breeds			
Black Bengal	India, Pakistan Bangladesh, Sri Lanka	45–50	Meat
S. China	China	50	Meat

Dera Din Panah

A black or red coloured goat that is found in the Dera Din Panah region of Pakistan where it is a useful supplier of milk, fibre and meat. Daily milk yields above 4.9 litres have been recorded at 4.9 per cent butterfat. Around 1.0kg of hair is produced annually. Animals can be tall (80cm) and females reach 40kg and males 45kg. The ears are pendulous, the nose Roman and the horns thick and twisted.

Fig 2.6 *Jamnapari goat*

Fig 2.7 *Angora goat*

Jamnapari

This breed (Fig 2.6) is the most common milking goat in Asia and has been used in the Middle East and Syria in breeding programmes. It is a very large goat with very long lop ears, a convex profile to its face and a variety of colours. Males weigh 90kg and females 65kg. Milk yields average over 1.0 litres/day over eight-month lactations. Singles are more common than twins.

Kashmir

(see also fibre in chapter 8)

The Kashmir is well adapted to the cold, dry conditions of the high mountain areas of Central Asia, rather than to high temperatures. Goats are usually white and covered in thick, fine and long hair. The principal value of the breed is its fine undercoat or pashmina. This grows in the winter and is shed in the spring when it can be combed out of the fleece. It is an ideal fibre for high-value fabrics. It has in recent years been the subject of much breeding improvement. Efforts have been made in temperate regions to raise the yield of pashmina from its current 50–100g to 500g. The outer, coarse hairs are traditionally used in rope making.

The goats are large, with males weighing 60kg, females 50kg. Litter sizes are around 1.2.

Malabar (Tellicherry)

This is a dairy breed found in the Kerala region of south-west India. It originates from a crossing of Arab and Indian breeds, which gives it its mixture of colours. It has a good dairy shape, with milk yields reaching 0.9 litres/day, and is very prolific with litters of 1.7. The skins are popular with the tanning industry.

Anatolian Black

This small Turkish breed has a hairy coat and is usually black, although brown and grey are seen. Males reach 42kg and females 35kg and measure 55–65cm at the withers. Litter sizes average 1.1 and milk yields of 0.5 litres/day with a 4.7 per cent butterfat are common. The fibre and meat are also used.

Angora

The Angora goat (Fig 2.7) is the premier hair-producing breed as the whole of its mohair fleece can be used in fabric manufacture. Annual clips range from 1.5–3.0kg and fibre can grow at 2.5cm a month up to a total length of 25cm. High fibre production results in a high nutrient requirement for protein and this can make animals on a poor diet particularly susceptible to parasitic infections.

Most Angoras are found in Asia Minor, but large populations exist in S. Africa, India, Australia and Pakistan. The Angora is best suited to hot dry rangelands and is unhappy in either extremely cold or very humid conditions. Typical Angoras are small (54–69cm), white and have curved horns. Single births are most common.

The meat of this breed is used although growth is slow (40g/day). Milk has a high butterfat at 5.7 per cent but daily yields are not large at 0.4 litres. The breed has been involved in many pure and crossbreeding programmes.

Problems of breeding with Angoras

As the Angora is the premier breed for fibre production it is important to recognise that this breed brings with it a number of production problems that restrict its potential. These are discussed here.

Given that fibre is the main product of this breed then selecting for fleece weight and fibre length and diameter are critical management factors. Kemp quantity, lock type, and face, neck and belly cover are also factors used in selection. Face cover can, however, be a problem as it may restrict selective grazing and thus growth. Some research suggests that goats with heavier fleeces give poor quality fibre, and selecting for this characteristic also leads to poor reproductive performance.

When kept in extensive systems the small Angora is susceptible to predation from wild animals as well as to cold stress. It also succumbs to heavy internal parasite burdens, which a poor diet makes worse. Some strains show a high tendency to recurrent abortion (up to 50 per cent), whilst others have very poor mothering instincts which lead to high kid mortality. The need to have access to leguminous browse or high quality grasses to provide good protein levels for strong fibre growth is perhaps

one reason why the breed is not more widespread.

Cold stress is a condition that may occur when the goat is freshly clipped and then exposed to sudden cold winds, rain and low temperatures. Angoras are very susceptible to heat loss, especially at high altitudes, because of their small size and lack of fat cover under the skin. Clipping in early summer would overcome the cold stress problems, but if this was the only harvest each year the farmers' income would be greatly reduced.

Other problems associated with mohair production from Angoras are managerial. Poor handling can cause stress, which leads to scouring and stained fleeces. When animals are grazing in areas with thorny or dense bushes a lower quality of mohair will result because of seeds and twigs becoming tangled in the fleece, causing tearing. The best quality fibre comes from Angoras of 18 months of age, but yields at this stage may not be very high.

Katjang

This is a popular meat breed in Malaysia, the Philippines and Indonesia. It is black with occasional white patches and a thin coarse coat. The horns are scimitar-shaped and curve back and up. The ears are short and upright. Males have beards and average 30kg. Twins are common with this hardy and prolific animal, giving an average litter size of 1.7. Nannies are poor milkers; consequently kids grow only slowly. The meat is good quality and expensive. Skins are used in handicraft manufacture.

3.3 Dwarf breeds

Black Bengal

As the name suggests this goat is found in the Bengal and Assam regions of India and north Bangladesh. It is a very short goat measuring only 40–45cm in height and is normally black although fawn and brown variants are seen. Both sexes have short scimitar horns and small pointed ears. Goats' weights range from as little as 9kg to as much as 28kg. Coats are short-haired and soft.

This breed matures very early and multiple births are more common than singles. Milk production is very low so that kids receive insufficient nutrition and grow only slowly. The principal product is meat but the skins are also used.

South China

This breed is similar to the Katjang goat but slightly shorter at 50–55cm. It weighs only 25–30kg and is very prolific and twins are common. These goats are kept for their meat.

4 *Goats in America and the Pacific*

Criollo (Creole)
Goats were introduced into Central and South America by sixteenth-century explorers from Europe. The present day goats have resulted from crossbreeding, with new introductions that were imported within the last 200 years. Most goats are black or brown with white patches. Horns are common and scimitar shaped. Ears are short and pricked. Most animals measure 50–60cm in height and have rough coats. Milk yields are low, so most goats are kept for meat.

Moxoto
Found in north-east Brazil, these animals are coloured brown or fawn with black stripes along their backs and belly, with black legs. The coat is short-haired and animals weigh 30–35kg. The goats live in very arid and hot regions to which they are well adapted. This breed is kept for its meat and skin.

Fiji
Found in the Fiji Islands, this breed resembles the Katjang being small, short-haired, hardy and of many colours. Over the years Angora, Anglo-Nubians and Saanens have been introduced to improve mohair and milk yields respectively. Goats are all horned and weigh 20–25kg. A litter size of 1.6 shows good fertility. Meat, which is highly prized by Fijian Indians, is the prime product.

Table 2.3 Breeds in America and the Pacific

Breed type	Location	Height(cm) at withers	Function
Angora	Texas, USA	56–60	Fibre
Criollo	W. Indies, S. and C. America	50–65	Meat
Moxoto	N.E. Brazil	63–65	Meat/skin
Fiji	Fiji	58–66	Meat

5 *Temperate breeds in the tropics*

The following temperate breeds are found in various countries in the tropics and are dealt with in detail in chapter 9.

- Alpine
- Saanen
- Toggenberg
- Anglo-Nubian

3 Nutrition and feeding

1 *Introduction*

Goats are ideal animals to convert low quality fibrous vegetation into useful products for man. These include meat, milk, skin and manure. Goats prefer a varied diet and to be able to wander and browse a broad range of plants. In traditional systems they make good use of the available vegetation. Because of their browsing habit they are often able to exist in areas of low rainfall and poor growth, where cattle and even sheep would not prosper. If their numbers do not become excessive, a good ecological balance can be maintained.

Goats, being inquisitive eaters, will eat all types of vegetation as well as articles which have little food value, such as cardboard and people's hair! However, given the opportunity, they seek good pasture where they can select the grasses they prefer. They will often reject the legume clover which is favoured by sheep and cattle. This means that combining sheep and goats to graze in a single flock does not necessarily lead to competition between the two species. Where a wide range of plants is available it is possible to keep more animals on a given area of land because each species grazes on a different type of vegetation.

2 *Anatomy*

Goats are ruminants. This means that they have a four-stomach digestive system which comprises rumen, reticulum, omasum and abomasum (Fig 3.1). In the adult goat the rumen is the largest of the four. These stomachs enable the goat to extract nutrients from fibrous materials using bacteria and protozoa which live in the rumen and reticulum. (For more information see the book in this series by John Chesworth on *Ruminant Nutrition*)

Food is initially chewed in the mouth and mixed with saliva before it passes to the rumen. This material is returned to the mouth for further chewing so that the particle size is reduced, speeding up subsequent

digestion. This regurgitation is called *chewing the cud*. Like all ruminants, goats can be seen chewing and re-chewing this material between grazing periods. They chew the cud more at night than during the day. After thorough cudding the food passes to the rumen and reticulum, where micro-organisms break it into simple chemicals which are either absorbed into the body or are used by the micro-organisms to reproduce. The population of micro-organisms found in the rumen is specific to particular diets and gradually changes in response to changes in the types of food being eaten. If a sudden change of diet occurs the system is upset because the micro-organisms cannot digest the new feeds. It takes days for the appropriate micro-organism populations to build up to cope with the new diet. The sudden introduction of a new food can lead to scouring and loss of condition or even death in severe cases. For goatkeepers this means that any change in diet must be very gradual. A new food should be given in very small amounts at first, with the quantity being increased progressively over a period of days.

The liquid mixture of the rumen and reticulum passes to the omasum, where most of the water is removed, and then to the abomasum. This stomach is very acidic and any micro-organisms reaching it are killed. Digestion from this point progresses with the addition of enzymes which are secreted in the gut wall. The digestive contents are now broken down

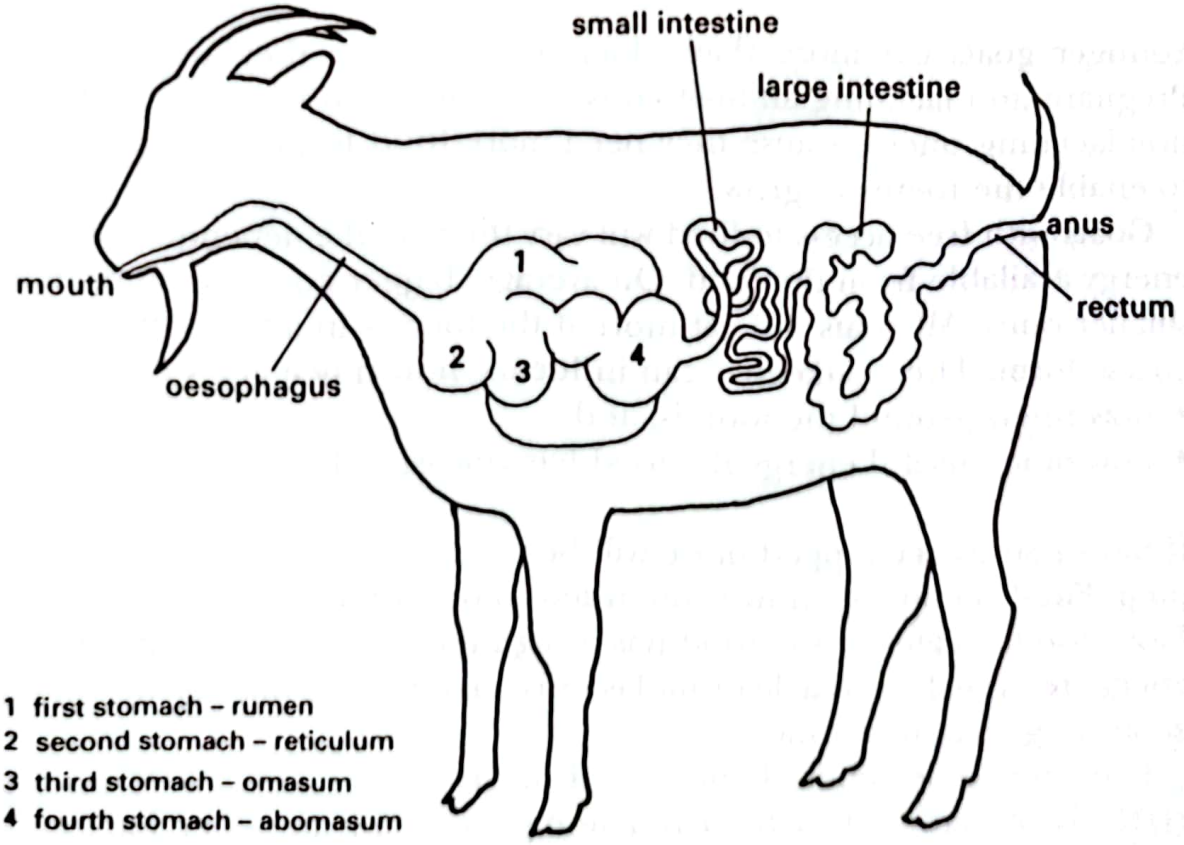


Fig 3.1 *Digestive system of the goat*

into nutrients that are useful to the body. These are absorbed by the small intestine. This part of the gut is very long but is accommodated as a series of coils so it takes up as little room as possible. More of the water is removed in the large intestine before the very dry dung pellets are expelled from the rectum through the anus. Goats are able to extract almost all of the water from the contents of the digestive system, which means they can make very efficient use of whatever water is available. This is one of the reasons why goats can survive in arid regions. It is considered a sign of good health if the dung is reasonably dry.

3 *Food intake*

In the tropics dairy goats will eat up to the equivalent of 4–5 per cent of their own body weight in dry matter daily. Meat goats will consume about 3 per cent. In cooler parts of the world dairy goats have been known to eat up to 8 per cent. Goats have a much better capacity for forage than sheep of a similar size. How much a goat eats depends on its:

- age
- breed
- production capacity, or
- whether it is pregnant/lactating.

Younger goats eat more than older ones because they are growing. Pregnant and lactating animals consume more than non-pregnant and non-lactating ones because they need more food to produce milk and to enable the foetus to grow.

Goats with free access to food will vary their intake depending on the energy available from the food. On average, bigger goats eat more than smaller ones. All goats will eat more if the food is in a fine rather than coarse form. The goatkeeper can influence how much goats eat by:

- how finely ground the food is; and
- how much useful energy the food has (measured in ME per kg DM)

If hay or straw is chopped more will be eaten than if fed without chopping. Finely chopped straw is often fed as part of a concentrate ration. More food is eaten if the food has a high energy density. So if a high-energy feed such as treacle or molasses is mixed with a fibrous food such as straw, goats will eat more.

Food intake is generally measured in dry matter terms. Dry matter (DM) is the amount of food remaining when all the water has been removed. It is used as a guide to how much fresh or moist food can be fed.

Feeding example 30kg goat

A 30kg goat requires:

for maintenance 1.6% DM as % liveweight	=	0.5kg
for production 3.0% DM as % liveweight	=	0.9kg
		1.4kg

If DM of food is 25% four times as much is needed to achieve a set target figure, therefore:

$$1.4 \times 4 = 6.4\text{kg fresh material daily}$$

4 *Nutrients*

Much of the information used to calculate nutrient requirements for goats is based on research with sheep and cattle.

For goats you need a balance of five basic components.

1 Energy
2 Protein
3 Vitamins
4 Minerals
5 Water

All goats have a basic need (maintenance) for energy nutrients but some will also require additional (production) nutrients at particular times, for example, nannies in the final stages of pregnancy or when lactating, or kids when they are growing.

4.1 Energy

The energy from food is used by the goat for maintenance (M) and production (P). Maintenance is that amount needed to maintain the animal in a stable body condition and provide enough energy for walking. Production is that required for growing and for producing milk or a foetus. It is required over and above the energy for maintenance. Not all energy in food can be used by the goat and so only the part that can, the Metabolisable Energy (ME) part, is used to calculate how much energy is needed for a goat's maintenance and production.

Energy is measured in Megajoules (MJ) or calories. (One calorie = 4.2 joules.) An average diet contains about 8.5 Megajoules (MJ) of Metabolisable Energy (ME) per kilogram of dry matter (DM). However, the amount may range from 6 to 13 MJ/ME /kg DM.

To estimate the amount of ME in a food it is necessary to undertake a

feeding trial to find out the digestibility of the food. Digestibility measures that part of the food which is absorbed from the digestive tract into the body. There is a direct relationship with ME, shown as:

$$ME = 0.15 \times DOMD$$

ME is in Megajoules per kilogram of dry matter(MJ/Kg DM). DOMD is digestibility of organic matter in the dry matter.

Alternatively, small amounts of food can be placed in an animal's rumen in a small bag and the amount absorbed recorded over a period of time.

Very few of either of these measurements have been undertaken with goats in the tropics, so the amount of information specifically applicable to goats is limited. In consequence, calculations for nutrition often have to rely on figures that have been found in research on cattle or sheep and also often based on data from the temperate regions of the world rather than the tropics.

Table 3.1 below has been derived from experiments undertaken in the tropics and gives a guide to daily amounts of energy required by goats of different weights kept under different husbandry systems.

4.2 Production

For pregnant or lactating females or growing kids energy is required over and above the amount needed to maintain body condition given in Table 3.1.

Table 3.1 Daily maintenance requirements of energy

Goats liveweight (kg)	Requirement (MJ/ME)	
	Confined	Intensive
10	2.32	3.25
20	3.91	5.47
30	5.30	7.42
40	6.58	9.21
50	7.78	10.89
60	8.92	12.49

Source: Devendra, 1982

For lactation the energy (ME) required relates to the energy content and composition of the milk produced. A typical energy requirement is shown in Table 3.2.

Table 3.2 **Nutrient requirements for lactation (per kg of milk)**

Fat content of milk (%)	ME (MJ)	DP*	Calcium*	Phosphorus*
3.5	4.5	47	0.8	0.7
4.5	5.2	59	0.9	0.7
5.5	5.7	73	1.1	0.7

Source: Devendra and McLeroy, 1982
*grammes per kg of milk
DP = digestible protein

Pregnancy Nannies require sufficient energy to feed the growing foetus or foetuses. In the last part of a pregnancy the female's requirement rises substantially and particularly if she is carrying two or three kids. Other nutrients follow a similar demand curve. The quality of feed and its energy density must rise in this part of the pregnancy if the kids are to be born at a reasonable weight. If the nanny receives too little energy she will become thin as her own body reserves are used to grow the kids. She may develop pregnancy toxaemia (ketosis) and die if the situation gets worse. Levels of energy intake are also required to achieve sexual maturity and for successful conception.

For *growth* the level of energy available to growing kids depends on the rate at which they grow. Research in East Africa suggests 0.035 MJ/ME is required per gram of growth. A 20kg animal gaining 50g daily requires 1.75 MJ/ME for growth.

4.3 Protein

All goats should have a minimal level of **crude protein** each day. Crude protein (CP) is calculated from the nitrogen content of a food.

$$CP = \text{nitrogen} \times 6.25$$

(It is expressed as a percentage (%))

Protein can also be synthesised from non-protein nitrogen such as urea. The crude protein content of a feed is calculated in the laboratory and, in temperate countries, tables are available showing values for many feeding materials. This is, unfortunately, not the case with most tropical feedstuffs. Much less is known about specific protein requirements for goats in the tropics. Figures that relate to sheep are commonly used instead (Table 3.3).

Table 3.3 Crude protein levels of typical feedstuffs

Typical feedstuffs	Crude protein contents in DM %
Straw	3–4
Cereals	10–12
Grass	10–22
Oil seed by–products	22–55
Green legumes	17–20
Fish meal	65–70

So if a very high fibrous diet (e.g. straw) is fed it may be low in protein. Additional crude protein, such as fish or oilseed meal, should then be added to the feed as a supplement.

A 35–40kg nanny requires about 30g/day DCP (Digestible Crude Protein) for maintenance. For pregnancy and lactation this rises to 70g/day. For growing kids the requirements vary with size of kid and daily rate of growth. A 10kg kid gaining 100g/day would need some 30g DCP whilst one at 30kg would need 50g/day.

4.4 Vitamins

Little research has been done on the vitamin requirements of goats and on vitamin deficiencies in tropical diets. In many situations goats do not suffer from a lack of vitamins where they have access to pasture or rangeland. Most diets have sufficient vitamin A (Carotene), vitamins D and K if green vegetation is available. If vitamin B_{12} is deficient, as characterised by anaemia, loss of appetite and poor growth, goats should be given cobalt, which will assist intestinal microflora to synthesise the vitamin. Vitamin C does not need to be added to the diet as the goat is able to synthesize sufficient for its needs.

4.5 Minerals

Minerals are important in the diet to keep goats healthy. There are two groups of minerals. Macrominerals(Major) are required in larger amounts whilst microminerals (Minor) are needed in very small quantities. The minerals needed in goat diets are given below.

Major		*Minor*		
Calcium	Sodium	Iodine	Selenium	Molybdenum
Phosphorus	Chlorine	Copper	Fluorine	Nickel
Potassium	Sulphur	Cobalt	Iron	Zinc
	Magnesium		Manganese	

Table 3.4 Typical mineral deficiency symptoms

Cobalt	Poor appetite, dull coat, anaemia, reduced milk
Copper/molybdenum	Swayback, scouring, stiff legs, dull coat
Iodine	Goitre, weak legs, low milk yield
Selenium	Infertility
Iron	Anaemia
Magnesium	Grass staggers
Calcium/ phosphorus	Poor bone growth Arthritis

Some soils suffer from mineral deficiencies or have minerals that are not available to plants and so are not ingested by goats. Copper, cobalt and selenium are good examples. If goats receive insufficient copper they grow slowly and kids may be born unable to walk on their back legs. Giving copper to the nanny can prevent this condition, but care must be taken not to overdose, since this may lead to death from copper poisoning. The only exact way of knowing whether a goat is short of copper is to take a blood sample and have it analysed.

One method of giving copper is by an injection under the skin twice yearly. Alternatively, boluses can be given to the goat to swallow. These remain in the stomach and slowly release copper over a six-month period. They are not as effective in goats as in sheep, however. The easiest solution to most minor mineral deficiency problems is for goats to have access to a composite mineral lick. These can be purchased from feed companies or sometimes local rocks or salt blocks are available. In intensive systems minerals can be added to the concentrates feed. Selenium and cobalt can be given as a liquid drench to counter any deficiency of these minerals.

Calcium (Ca) and phosphorus (P) are important minerals in milk production and a lack of calcium in the diet may lead to milk fever in newly-kidded nannies. This condition can be fatal. As a guide 0.9g of Ca and P should be available per 1kg of milk produced.

Mineral toxicity or deficiencies are less commonly seen in an acute form than a chronic one. Copper deficiency, when most severe, will produce *swayback* in kids. This means the young cannot use their hind legs in a coordinated way because insufficient copper was available in pregnancy to allow good bone growth. Where the deficiency or toxicity is less severe, more chronic symptoms include:

- scouring
- poor fertility
- hair loss
- poor appetite and growth.

Because these are also normal indications of poor nutrition and parasite infestation, identifying mineral deficiencies is difficult and best confirmed by the analysis of blood samples.

4.6 Water

All animals require access to water to enable them to perform normal body functions. This should ideally be fresh and clean. The more continuous the access the better the animal's metabolism performs and the higher its production. In practical terms, however, watering animals usually takes place once or twice daily or even every other day. The amount of water needed by a goat depends upon:

- amount of dry matter eaten
- nature of the food
- whether the goat is lactating
- air temperature
- drinking frequency
- water temperature.

If goats eat succulent foods, which have a high moisture content, they need to drink less than they do when fed on dry food. In desert conditions they will lick the dew from the trees. If water is cool or available at all times goats will drink less. In hot conditions goats keep cool by seeking shade under trees or rocks and will pant and sweat when the air temperature exceeds 39°C. Panting causes loss of heat by evaporation of water from the lungs. Indigenous goats have a reputation for being very tolerant to heat stress and having a reduced demand for water. Long or shiny coats are thought to help protect the skin from the sun's heat. Exotic breeds, on the other hand, are less adaptable and tend to eat less in hotter conditions which leads to body weight losses. Compared with sheep, goats pant less and lose less water in the faeces and urine.

To achieve maximum efficiency, goats need to drink 4kg of water for every 1kg of dry matter they consume.

Water is more critical for growing kids and pregnant or lactating nannies than it is for other goats. The smaller an animal is the more water it needs relative to its size. This is because it has a large body surface in relation to its body size which makes it susceptible to heat stress.

Goats tend to thrive better than sheep under difficult range conditions because they are able to tolerate brackish or salty water which is often found in high temperature areas or near the sea. For example, salt concentrations of 10,000 ppm (parts per million) in the water are well tolerated.

In arid regions or in the dry season the number of watering places

declines and flocks may have to travel long distances to drink and then wait their turn behind herds of larger camels or cattle. This reduces time available for grazing as well as causing overgrazing around waterholes.

4.7 Supplementation

Most farmers in the tropics cannot afford to give their goats any food over and above what the animals can graze. By being able to select particular plants, goats may be able to increase the quality of their diet, especially with regard to energy or protein levels. In practice, their diet consists almost entirely of low-value roughages. In these situations feeding a supplement to the diet can have a dramatic effect on productivity especially during the dry season, during late pregnancy or where animals are stall fed.

Supplements can be given as:

- concentrates containing extra energy (molasses, cereals)
- protein sources (legumes)
- non-protein nitrogen (urea)
- minerals/vitamins (salt licks).

Supplementary feeding is a costly exercise and only worthwhile if the improvement in performance gained is greater than the cost. If feeding pregnant nannies in the final month of gestation gives larger kids that grow well and can be sold for higher prices then supplementation may be worth doing. This is especially so if the supplement is cheap to obtain. Tree fodder is one example and agricultural by-products may be another.

5 *Practical feeding*

In practical terms the following periods are important ones to consider when feeding goats:

- bucks and nannies 1 month before mating
- nannies for the 3 weeks after mating
- nannies the final month before kidding
- first 2 months of lactation
- growing kids, especially post weaning.

Only in selected situations are concentrates likely to be either available or given as a supplement. More likely supplements are legumes or crop residues. These might include Leucaena, stylos, pigeon peas, sweet potato stems/leaves, groundnut haulm and cassava leaves. Typical diets, including supplements that could be fed to goats, are given in Table 3.5.

Table 3.5 Typical diets for goats

Typical rations			Concentrate ration* (16% protein)	
		kg/day		%
1	Fresh grass	2.0 – 3.0	Cassava chips	18
	concentrates	0.3 – 0.8	Molasses	15
	(16–18% protein)*		Coconut cake	35
	or		Groundnut cake	30
2	Grass/legumes	1.8 – 2.5	Salt	1
	concentrates	0.3 – 0.8	Mineral mix	1
	(16–18%)*			100
	or			
3	Hay	0.7 – 1.0		
	concentrates	0.3 – 0.8		
	(16–18%)*			

When not being used for mating, bucks do not normally need supplementary food. A small quantity of concentrate in the 3–4 week period before breeding will help build up body condition of bucks. This is important if the males have many nannies to mate or if climatic conditions are harsh. Bucks can lose a great deal of weight during the mating period.

Feeding nannies immediately before and for three weeks after mating keep them in good condition and will help the implantation of fertilised eggs in the uterus.

By far the most critical period during which correct feeding is important for the nanny is the last month of pregnancy when the foetuses are growing very rapidly and causing a severe strain on the mother's body reserves. Reducing the ration immediately after kidding and then building it up again over the first three weeks of the lactation until weaning, will encourage good milk production.

If nannies are in very poor condition at weaning, supplementary feeding will enable them to regain body condition and to be in a good state for mating and conception. It is hard to justify the cost of feeding kids concentrates. Supplementary feeding of kids after weaning will stop them losing weight that often occurs when the nannies' milk is no longer available to them.

6 *Dry season feeding*

Many parts of the tropics have long periods when little or no rain falls. Consequently vegetation dies back and surface water disappears. The

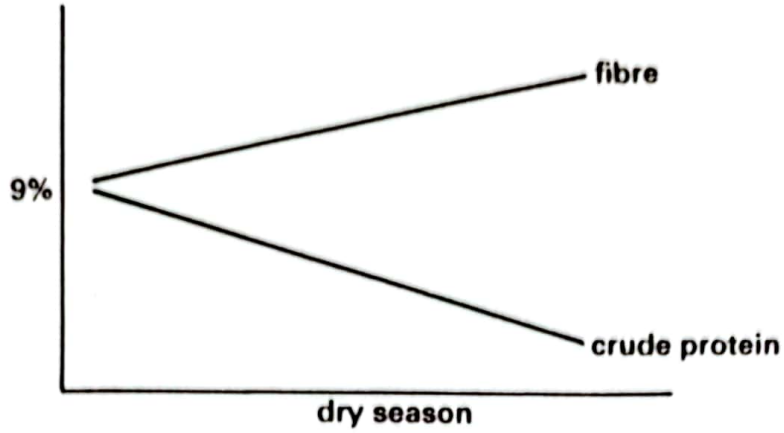


Fig 3.2 *Fibre content of forage*

quality of the vegetation also declines, with the best being eaten first. The longer the dry period lasts the poorer the quality of the roughage becomes (Fig 3.2). Goats will then eat less of this material.

If the nutrients in the food are less than required for an animal's maintenance it will begin to lose weight as body reserves are depleted. As this happens the females will become anoestrus and so not breed. Nannies that are already pregnant will produce very weak kids. In very long dry seasons animals will die, with the youngest, weakest and oldest dying first.

Goatkeepers may counter these adverse effects by feeding goats on tree leaves or legumes. This practice can lead to deforestation problems when many animals are kept. This has happened in some areas of the Third World such as Nepal and the Sahel region of Africa.

7 *Grazing behaviour*

Goats are selective and agile feeders. They will walk a long way searching for food and are happier having a range of vegetation available to them including trees, shrubs and grasses. Shoots and leaves are preferred to stems. In intensive units goats, if not managed effectively, will refuse and spoil a high percentage of forage offered.

When goats are first let out on to pastures in the mornings they will initially graze unselectively but then start to wander and become increasingly selective. Unlike sheep, goats will scatter and graze and browse individually, climbing trees or standing on their hind legs to reach browse at higher levels (Fig 3.3). They will stop grazing if disturbed, for example, by rain. In hot conditions goats favour grazing in the early morning and evening. In Arabia they will graze at night if allowed, preferring to seek out comfortable shade during the heat of the day.

Fig 3.3 *Goats in trees in Oman*

Where goatkeepers can control their animals under extensive systems they may be able to use range better if they allow sheep and goats to graze together. These two species are complementary in habit which means more animals may be kept in a set area. The sheep will graze the lower grasses whilst the goats will browse shrubs and trees.

Good goatkeepers will know the browsing habits and movement patterns of the flock and their favourite watering and sheltering spots. They will allow natural resting times in the middle of a day and know when to move the flock. Goats are much more difficult to move during cold, wet or windy periods.

Goats change their feeding habit between seasons. In the dry season they will eat bushes and trees which in wetter periods they would ignore, preferring in this season grasses and legumes. They can distinguish bitter, sweet, salty and sour tastes and show tolerance to bitter and salty tastes.

Although goats do not flock together in the way that sheep do, they do have a good *herd* instinct and if handled frequently become used to being moved or herded in large groups. Calling to them when feeding them will teach animals to move together for handling. Identifying the dominant females and males whom others will follow can also be useful.

8 Agro-Industry by-products

Industries that process agricultural produce often leave residues or by-products that can be fed to animals. The feeding value of such by-

products varies considerably. Some examples are listed in Table 3.6 but the same product's feeding value will change with different samples. Feeding a product to a small number of goats to observe the effect is one solution to this problem. Some by-products, such as molasses and cassava, are high in energy but low in protein whilst others, such as linseed meal or dessicated cotton seed cake, have good levels of both protein and energy.

Table 3.6 By-products as a source of energy and protein

	Protein	Energy
Brewers' grains	✔	✔
Cassava peelings	–	✔
Sugarbeet molasses	–	✔
Rice husks	–	–
Sorgum stover	✔	–
Wheat bran	✔	✔
Coconut cake meal	✔	✔
Cotton seed cake (dessicated)	✔	✔
Linseed meal	✔	✔
Soyabean meal	✔	✔
✔ = good		

9 *Weed control and eradication*

Goats have been used successfully in some temperate regions to control or help eradicate certain weeds. They have a preference for eating plants such as thistles, broom, ragwort and gorse which cattle and sheep would normally avoid. By grazing these out goats have helped improve rangeland in New Zealand, USA and S. Africa (Fig 3.4).

Castrated males or goats that are kept for fibre production have been found to be better at weed control than pregnant or lactating females. This is because the males do not require the additional nutrition that is essential for females in pregnancy and lactation. If the goats have long coats these might be damaged on thorn bushes. Keeping 10 goats per ha over long periods has been found to be very successful. Rates above this may lead to stress and health problems. For the best weed control the animals have to be set stocked or rotated around the pasture in front of a flock of sheep or herd of cattle. In both cases goat-proof fencing is normally used. This, unfortunately, makes the exercise expensive and so impractical in Third World situations.

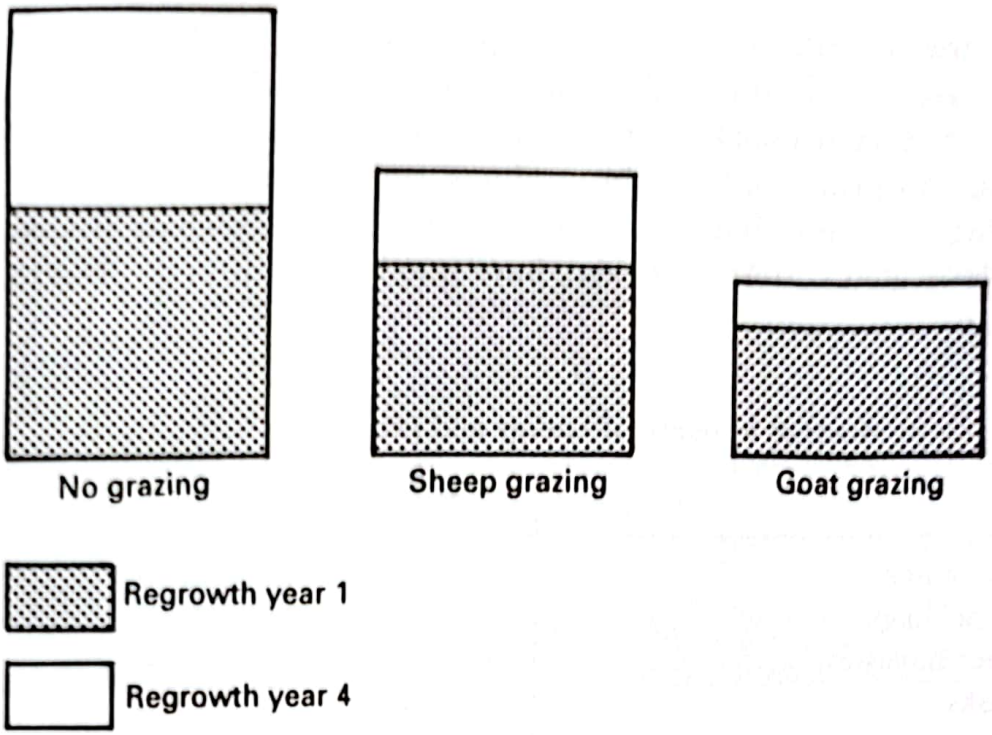


Fig 3.4 *Control of thorn bushes by goats in New Zealand*

Some weeds are eaten by goats only at specific stages of their growth. Thistles, for example, are eaten only at flowering. The destruction of weeds by grazing therefore needs careful timing to be effective. Goats will eat small plants from the top down but will attack taller ones from below. On taller shrubs they will strip the bark from the stems, thus ring barking them, which may cause their death. Goats are very effective in controlling original weed growth, but their grazing has less impact on weeds that subsequently regrow.

4 Reproduction and kid rearing

1 *Terminology*

Listed below are some of the most common terms used when referring to reproduction in goats:

fertility	ability to produce sperm or ova
prolificacy	ability to produce young
litter size	number of kids born to each nanny each birth
kidding percentage	number of kids born or reared in relation to nannies exposed to buck
kidding interval	number of days between two successive kiddings
service interval	period from kidding to next oestrus
conception	implant of fertilised ova that grows to foetus
foetus	growing young in female
service	mating
heat	oestrus

Fertility is affected by both environmental and genetic factors. Differences thus exist between breeds, but management, climate and disease can all influence fertility.

For the farmer, fertility is seen as the ease with which a nanny successfully conceives after kidding. The shorter this period or the fewer the number of services the more profitable the exercise and the happier the farmer. The farmer would consider the number of services needed to get the nanny pregnant to be an indicator of fertility of the buck.

Prolificacy improves with age, with most nannies progressively giving more kids per litter up to their fifth or sixth kidding. Prolificacy is measured by litter size, kidding interval, kidding percentage or service period. These figures are usually expressed as per animal or for a group of animals. Thus the average kidding interval for the West African Dwarf is 258 days. Its litter size is 1.6.

Litter size, which is influenced by the female's body size, gives an indication of how many kids a goat would normally have.

Table 4.1 Average litter sizes

Tropical breeds		European breeds	
Black Bengal	1.4	Anglo-Nubian	1.6
Boer	1.5	Alpine	1.5
Red Sokoto	1.5	Saanen	1.9
Sudanese Nubian	1.6		
West African Dwarf	1.8		

Kidding percentage is a useful measurement if calculations are taken at weaning rather than kidding time because it then shows the nannies' ability to rear as well as produce kids. It may also show losses from abortions and those nannies that failed to conceive.

If 50 nannies were put to the buck and 40 kids were successfully weaned then the calculation would be:

$$\frac{40}{50} \times 100 = 80\%$$

Kidding interval is a helpful way of comparing fertility and productivity between flocks or breeds. It compares how quickly nannies become pregnant, produce kids and conceive again. In areas where all year round breeding is possible, nannies can produce a litter every eight months.

Service period may be a useful measure if a short kidding interval is needed. This can be achieved if the period between kidding and first oestrus is also short. Good care and feeding of the lactating nanny plus accurate detection of oestrus are all required to obtain a short service interval.

2 *Reproduction in bucks*

(For more information on this subject see the book *Animal Breeding* by Gerald Weiner in this series.)

In order to make the most efficient use of the potential for rapid reproduction of a goat flock it is necessary to understand the reproductive characteristics of the goat. This knowledge can then be incorporated into the management of the flock. Much of the breeding of goats in the tropics is unplanned and fails to exploit the animals' potential.

Biological reproduction is the fusion of two cells, one each from the male (the sperm) and female (the egg). These cells carry the chromosomes within their nuclei which in turn carry all the genes which control the characteristics of the animals.

The aim of controlled breeding is to select characteristics that are of benefit to the goatkeeper. These can include better milk or meat production, good reproductive ability or climate tolerance.

Goats have 60 chromosomes compared with the 54 of sheep, and Hemilrague goats which have 48. Whilst sheep and goats may mate with each other, this will not under normal conditions produce live young. Infertile hybrids have been produced under experimental conditions.

2.1 Anatomy of the male goat reproductive organs

The scrotum hangs beneath the abdomen and contains the two testes (Fig 4.1). Sperm are produced in the testes and stored in the epididymis where they can remain fertile for over a month, after which they are reabsorbed. At mating the male goat mounts the female and semen is ejaculated into the female vagina through the penis. The semen is a fluid containing the sperm.

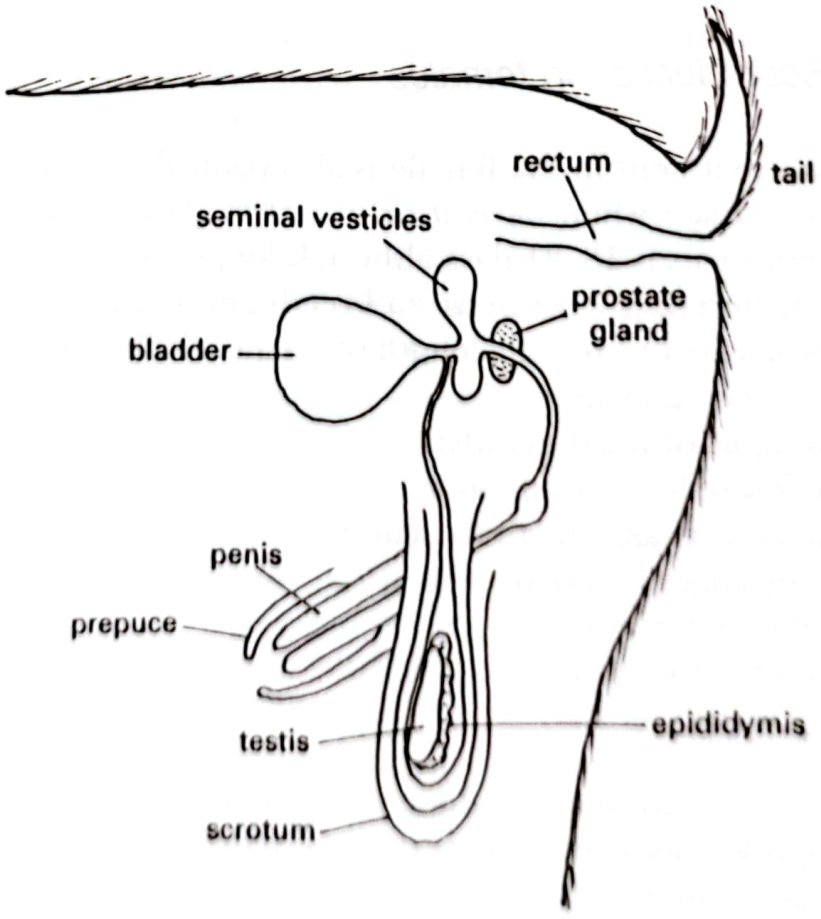


Fig 4.1 *Anatomy of the male goat reproductive organs*

In the buck, sperm production, mating activity and some physical characteristics are all regulated by chemicals called hormones. These hormones include testosterone.

2.2 Puberty (males)

Puberty is the age at which young males first become sexually mature and are able to produce viable sperm. If used for mating at a very early age the quality of the sperm may be poor. The animal will also be inexperienced at mating or perhaps too small to achieve a successful mating. The advent of puberty is controlled by a number of factors including breed, level of feeding and the health of the animal. Conditions of high temperature and humidity may affect the onset of puberty.

Sexual excitement or libido indicates the bucks' desire to mate and male kids will mount females from an early age. Males can reach puberty as early as three months of age which means castration of the males or segregation of the sexes is required to avoid indiscriminate or undesired breeding. This is best done before kids reach three months of age. Using males at too early an age may exhaust them and reduce their ultimate size and fertility.

3 *Reproduction in females*

Sexual excitment in the female is also controlled by hormones and she will only mate when *on heat* or in *oestrus*. The average length of time between heats is 18–21 days although longer or shorter cycles are common. Differences exist between breeds and individuals and at different stages of a goat's life. The length of the heat will typically be 24–36 hours but this too can vary.

The signs of heat include:

- swollen red-coloured vulva
- mucus discharge from the vulva
- tail flicking or shaking
- continual bleating
- mounting other goats
- seeking bucks.

Females may not show all these signs and heat may be difficult to detect. The goatkeeper can confirm that the female is exhibiting oestrus by its willingness to *stand* for mating. The presence of a buck can actually trigger oestrus and a majority of non-pregnant nannies will come on heat if they can smell or see the buck.

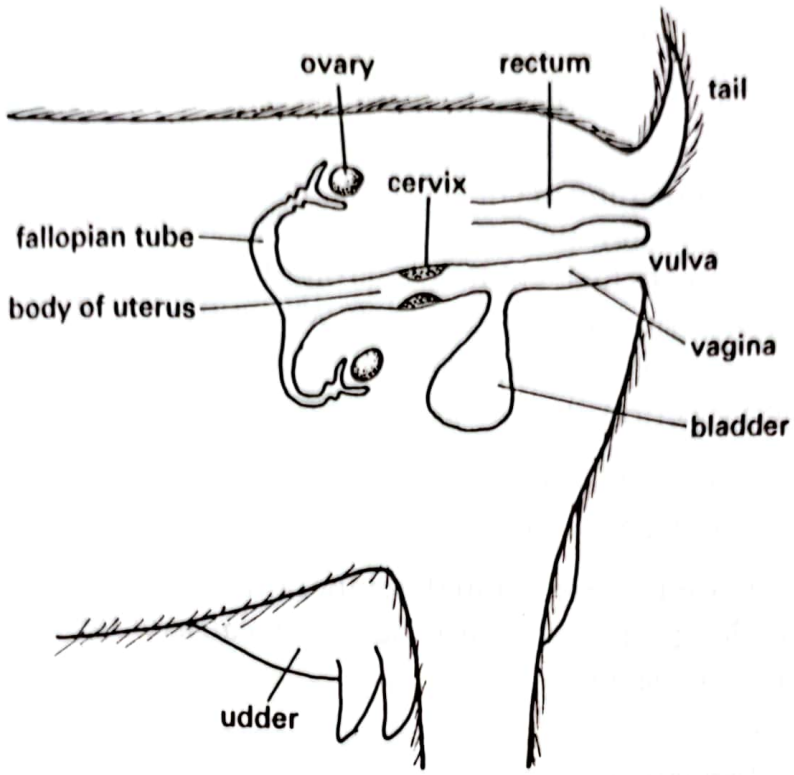


Fig 4.2 *Anatomy of the female goat reproductive organs*

Ovulation is the shedding of eggs from the ovary. This occurs 21–36 hours after the start of oestrus.

3.1 Anatomy of the female goat

The eggs are produced by the ovaries (Fig 4.2). The two ovaries produce eggs on alternate cycles and release them into the oviduct or fallopian tube from where they travel to the uterus. If mated successfully, sperm swim up from the vagina to fuse with the eggs when they are in the fallopian tube. This is called fertilisation. One sperm fuses with each egg. As goats normally have multiple sheddings of eggs, successful fertilisation will often result in twins and triplets. Once fertilised, an egg becomes embedded in the uterus wall, after which the pregnancy commences.

The hormones involved in pregnancy and oestrus include progesterone, oestrogen, prolactin, prostaglandins, follicle stimulating hormones and lutenising hormones.

3.2 Puberty (females)

Sexual maturity in the female occurs when it has a first heat and this can be as early as three months. Females should not be mated until they are

physically large enough to cope with both the pregnancy and the rearing of kids. If mated too young the female may remain stunted and any kids born will tend to be small with a lower chance of survival. She may also have difficulty in conceiving again.

Where breeding occurs all year round, well-fed females reach puberty sooner (6–7 months) and they can kid within one year. Under traditional systems first kidding is around 15 months. On average singles reach puberty sooner than twins. Where the breeding is seasonal, good nutrition ensures that the female reaches puberty in the first available breeding period after birth.

As a guide female goats should be mated only when they reach 70 per cent of the average adult female weight.

Goats reared in areas of high temperatures, such as the Middle East, may show a longer period to first oestrus because of the effect of heat on the hormonal system.

3.3 Anoestrus

Anoestrus is the condition of non-pregnant females that do not come back on heat. The consequence of this is that the time between kiddings is extended and so the biological potential of the goat is not fully exploited. Farmers thus make less money as their goats produce fewer kids over their lifetime. Anoestrus is caused by:

- poor nutrition
- high temperatures
- daylength changes.

In the tropics poor nutrition is the most important factor. This is especially so in semi-arid and arid areas where seasonal variations in quality and amount of food occur. As goats get thinner in a dry season the number of goats in anoestrus increases. This in effect restricts kidding to certain times of the year as they will not conceive in the latter part of dry seasons.

Whilst indigenous goats are well adapted to arid and semi-arid zones, heat stress from temperatures over 39°C may cause a higher degree of anoestrus with imported or exotic animals. High temperatures can also lead to longer oestrus cycles and make its detection difficult because normal signs of heat may be less obvious.

In parts of the tropics where feeding is adequate goats can breed all year round. In the sub-tropics and temperate areas where the length of daylight changes, oestrus is controlled by photoperiod. Nannies will show maximum sexual activity when day length is decreasing (autumn) and will cease cycling when day length is increasing (spring). Different breeds are affected by different day lengths.

3.4 Flushing

Flushing is the practice of giving female goats a good level of nutrition prior to mating. This stimulates the shedding of more eggs from the ovaries and can increase the number of kids born in each litter. It is common practice in temperate zones but is difficult to manage or justify in the tropics. Goats commonly produce multiple births but in a harsh nutritional environment may not be able to rear any extra kids.

Flushing is also very difficult to organise if the animals are at various stages of breeding and kept in one large flock. This is often the case in the tropics. Flushing is much easier where goats are stall-fed or tethered.

4 *Mating*

Once male and females are sexually mature they will display characteristic behaviour prior to mating. Unless restrained, both sexes will make strenuous efforts to reach each other and use their climbing ability to good effect. Both sexes are attracted by smell, sight and noise.

The nanny will:	The buck will:
• bleet	• sniff the vulva
• flick its tail	• curl his lip
• push the buck	• paw the nanny
• stand for mating.	• mount and mate.

The male will mount and serve the nanny more than once if access is allowed.

The buck is the best guide to detecting heat. Where small-scale farmers do not have their own male goat, oestrus detection is difficult. Sometimes other female goats will mount the one in heat.

In larger flocks one healthy, mature male to 30 to 40 mature females is required for normal breeding programmes. It is a wise precaution to have more than one male in case the main breeding animal goes sick. Here a 'pecking' order will develop, with the strongest male taking first choice of nannies for mating. Younger or weaker bucks will mate the remaining females.

Care must be taken when introducing new bucks to each other, as they will fight and damage themselves. Placing bucks in adjoining pens for a few days or in a very small area where they have no room to charge at each other will help them to get acquainted without damage.

Bucks must be in good physical condition for mating. If breeding is on a seasonal basis, extra feed given in the month before mating will compensate for weight losses that can occur during the mating period. A

buck's feet should be well trimmed and disease free. The abdomen should have no wounds or sores.

5 *Controlled breeding/contraception*

If goatkeepers can control the timing of breeding in their flocks they can encourage all the nannies to kid within a short period. This will greatly assist general management tasks such as weaning, castration, vaccinations and feeding. It should also mean that kids will all be maturing around the same time, which may help marketing. The simplest way to achieve this organised breeding programme is to keep the males away from the nannies until mating time. In some traditional systems leather or material aprons are placed either over the vagina or under the bucks belly to prevent mating. In both cases care must be taken to allow urine/feaces to fall clear, so that it does not build up and encourage flies and diseases.

5.1 Artificial insemination (AI) and embryo transfer (ET)

AI and ET are techniques that are well established in cattle and to a lesser extent in sheep in temperate areas. They enable the characteristics of superior males to be widely distributed. Such characteristics might include higher milk yield or larger litters. They are also cheaper and easier methods with less disease risks that can be used when importing new breeds. Importing semen for AI and frozen embryos for ET can be as or more successful than transporting live animals. But sheep and goat AI is relatively new and has disadvantages, including:

1 A lack of good sires.
2 No skilled personnel.
3 A need for sophisticated equipment.
4 Poor transportation.
5 Lack of cold chains.
6 High cost.
7 Poor on-farm management.

In most tropical situations AI and ET are unlikely to be used outside of research programmes or on very large commercial units.

Artificial insemination (AI)

Semen is collected in an artificial vagina from bucks as they mount a restrained teaser nanny. This is done throughout the breeding season. Semen volume and density vary with season, age of buck, temperature and nutrition. Quality is checked before use. This includes volume, concentration and sperm movement. Fresh semen can be used immediately to inseminate 10 to 15 females at the rate of 0.1cc per insemination.

Table 4.2 Typical semen characteristics (New Zealand)

Sperm volume ejaculate	0.1 – 2.66 cm^3
Sperm concentration	890 – 4010 million sperm/cm^3

Semen can be diluted with milk or special dilutant on a 1:2 or 1:4 basis and held at 4°C for up to 12 hours, during which it can be used to inseminate up to 60 nannies using 0.1cc each. For longer storage the semen is kept in plastic straws with milk and glycerol and frozen in liquid nitrogen. The straws are thawed when required by placing them in water at 37°C for 30 seconds.

Insemination takes place by placing the semen in the uterus or in the cervix using an insemination gun. Experimental results using fresh raw semen at natural heats have achieved pregnancy rates of 70 to 80 per cent. Under normal management conditions, the level of conception using thawed frozen semen is likely to be so low that we may question whether AI has a future in goat production.

Whilst it is possible that nannies can be inseminated at a natural heat, controlled or induced heats allow easier timing of insemination. Induced heats can be achieved by inserting progesterone-impregnated sponges into the vagina and leaving them for 17 to 18 days. The sponges are then removed and each female given an intra-muscular injection of Pregnant Mares' Serum Gonadotrophin (PMSG). Nannies are inseminated 48 to 60 hours later whether heat is seen or not. Using this procedure and fresh semen, it is possible to achieve successful conception rates of 60 per cent.

Embryo transfer (ET)

Embryo transfer involves the flushing (removal) of viable eggs from the nanny, fertilising them in a laboratory petri dish (called *in vitro fertilisation*), and freezing and storing the embryos which can then be implanted into other nannies for normal pregnancies and kiddings. Sophisticated equipment and veterinary equipment are required to undertake ET. It is thus an expensive procedure and, perhaps, only applicable to very valuable animals, for example where a new breed is being introduced into a country. It is unlikely to be available to many Third World goatkeepers in the near future.

6 *Care of the pregnant goat*

If strong kids are to result it is important to care for the nanny during pregnancy. Most foetal deaths occur immediately after mating. The implantation of the fertilised eggs occurs up to ten days after mating.

Any stress during the three weeks following mating can cause abortions. Nannies should be handled gently and protected from bullying at this time. It is very important that they are provided with sufficient room at food and water troughs to enable them to eat and drink in comfort.

The main aims during pregnancy are to:

- produce as many strong kids as possible
- keep the nanny in good condition so that she can rear her kids successfully.

If available, extra food should be given during the month following mating and more importantly in the final month of pregnancy. In this latter period the goat is unable to consume vast quantities of bulky low quality food because the growing foetus restricts space for the rumen (Fig 4.3). The nanny may thus be unable to eat enough to feed itself and the foetuses adequately. In temperate countries supplementary rations would be fed. An example could be:

100gm	cereal
250gm	good hay
1000gm	fresh grass

In the Middle East extra feed is given in the form of fresh lucerne (also called alfalfa) and dates.

6.1 Management pre-kidding

Throughout their pregnancy goats should be checked daily for lameness, ill health and fitness (panting or grunting!). They are best vaccinated against clostridial diseases and wormed 3 to 4 weeks before kidding. This means the kids are born into an environment with a low parasite challenge and with passive immunity against diseases that would otherwise be fatal during the first three weeks of the kid's life. If the nannies have thick shaggy coats, removing any hair soiled with faeces from around their rear will improve hygiene. Cutting off excess hair from around the udder will also help the kids to locate the teats when they are first born.

Regular visual inspections of animals will reveal most changes to their body condition. It is, however, a very good practice to feel individual animals during the pregnancy to identify those which are becoming thinner. This is especially important for goats with long or thick coats where the true body condition can be hidden by their coat. Once found, animals in poor condition should ideally be separated and given extra food. The body condition of the pregnant female should not be allowed to decline greatly during the pregnancy period. This will ensure kids

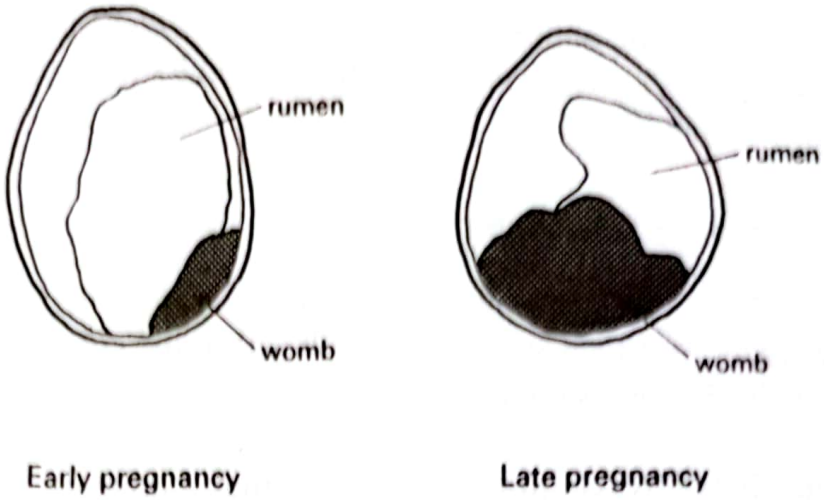


Fig 4.3 *Rumen volume is restricted by foetal growth in late pregnancy*

produced are a reasonable size and the nanny has ample milk to feed them.

6.2 Pregnancy diagnosis

If the nanny does not return to oestrus 2 to 3 weeks after mating she is considered to be pregnant and will kid some 145 days from the mating day. In late pregnancy the abdomen of the goat expands and it is possible to feel the feet of the kid by gently pressing the nanny's side. The number of foetuses and their stage of growth can be checked using ultrasonic scanners that were originally developed for human medicine and then modified for animal use. These machines are expensive and usually operated by specialists. They work by bouncing sound waves from a pad placed on the outside of the abdomen. When the sound comes back to the pad it is translated into a television picture that shows a section across the uterus where foetuses can be identified.

The blood or milk can also be analysed to test for the hormone progesterone. A pregnant goat has a high level of progesterone. Most goatkeepers will not have access to scanners and laboratories, although knowing how many kids a nanny is carrying can help identify those goats, with more than one foetus, that would benefit from extra feeding.

7 *Kidding*

Gestation length is modified by various factors including the size of the litter. The average length of pregnancy is 145 days but viable kids can be born in the range of 140–150 days. If mating is uncontrolled or not recorded, goatkeepers will only be able to estimate the date of kidding

from changes to the nanny's abdomen and her behaviour. Knowing the date of kidding is useful to enable help to be on hand to assist difficulties for both the nanny and her kids.

7.1 Signs of kidding in the nanny

In the 14 days before kidding two major changes occur:

1 The udder and teats swell as they fill with milk/colostrum.
2 The vulva becomes slack.

Immediately before kidding – stage 1 (lasting 2 hours or more)

1 The nanny isolates itself from the flock, seeking a dry, sheltered spot.
2 Becomes restless and uneasy.
3 Paws and scrapes the ground, sits and stands.
4 Stretches and strains with her neck skywards when sitting.
5 The water bladder appears, or fluid if it has already ruptured.
(This should not be confused with a prolapse – see page 49)
6 The nanny licks the fluid, wanders about but returns to selected spot.

Kidding – stage 2 (lasts about 30–45 minutes)

1 Within 1 or 2 hours of the water bag bursting the nanny starts straining to push out the kid (or the first kid).
2 The kid normally appears front feet and nose first. At this stage the nanny is normally lying on her side.
3 Once the kid is ejected the nanny will lick off the membrane covering the kid. This uncovers the mouth and nose and stimulates breathing (Fig 4.4).

Fig 4.4 *A newborn kid*

Table 4.3 Gestation table for goats – to estimate their date of kidding

(An average period for a pregnancy of a nanny in the tropics is 145 days (range 140–150 days))

Mating date		Expected kidding date		Mating date		Expected kidding date	
January	1	May	25	July	1	November	22
	14	June	9		14	December	6
February	1		26	August	1		22
	14	July	10		14	January	6
March	1		24	September	1		23
	14	August	7		14	February	6
April	1		24	October	1		22
	14	September	7		14	March	8
May	1		23	November	1		25
	14	October	7		14	April	8
June	1		23	December	1		24
	14	November	6		14	May	9

4 Subsequent kids normally appear within 30 minutes of the first. Their arrival may cause the nanny to ignore the first-born so it is important that it stands and suckles as soon as possible if it is to survive. An experienced nanny will stand for her kids to suckle.

5 Suckling within the first few hours of life is essential because the first milk or *colostrum* contains antibodies that enable the kid to resist diseases until its own immune system can cope. Colostrum also provides energy.

6 Once all the kids have been born the afterbirth or placenta is expelled. This is often eaten by the nanny and is considered to be a source of energy. If not eaten it should be buried so it does not become a source of infection or attract flies.

7.2 False pregnancies

Some goats may show all the signs of pregnancy but may only produce large quantities of fluid at kidding. This is called a *false* or *phantom pregnancy*. Nannies showing phantom pregnancies can be remated but should be culled if false pregnancies recur.

7.3 Prolapse of the vagina or rectum

In the one month before kidding some older goats may prolapse. Here the vagina is inverted and pushed out of the goat. Prolapses may be

caused by stress on the nannies, being overfat, overfeeding of bulky foods in late pregnancy and because of large kids or large litters.

If only part of the vagina prolapses it should be pushed back in once all dirt is washed off with clean water. This is best done with the goat on her back with her legs held upwards by an assistant. The vagina is then gently but firmly pushed back in place. In temperate countries where farmers have more access to veterinarians a repetition of a prolapse is prevented by using a special retainer (Fig 4.5) which is inserted into the vagina. This is usually made of plastic and must be clean when inserted.

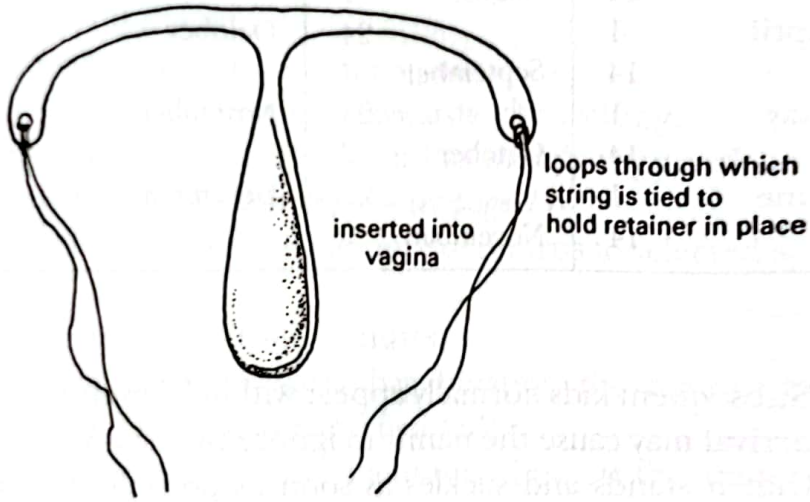
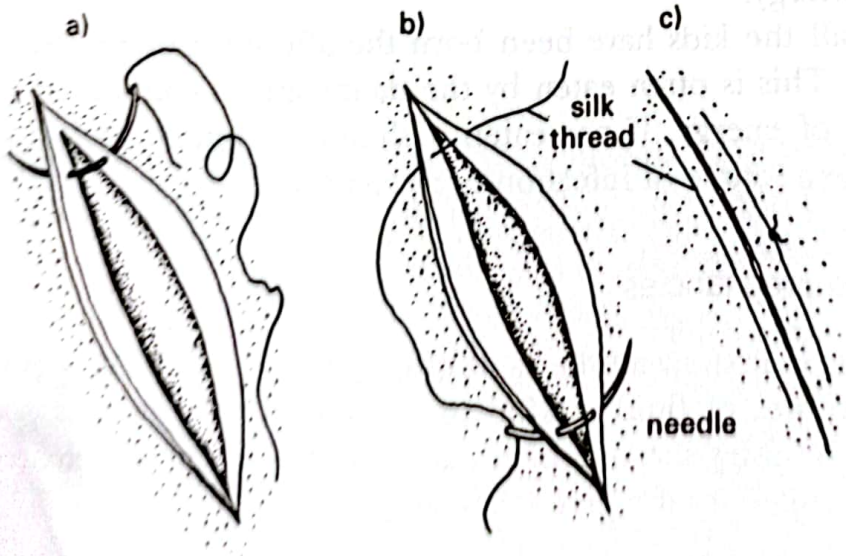


Fig 4.5 *Prolapse retainer*



Stitching the vulva as shown in a), b) and c) above is a foolproof method of holding in the vagina

Fig 4.6 *Stitching a prolapse*

The strings are tied to the hairs of the shaggy coated goats or to a loop of string that goes over the back and under the belly in front of the udder.

The device is pushed out at kidding when the first kid is born. Goats that have suffered prolapse are likely to do so again and so should be culled once the kids are weaned.

The traditional method of securing a prolapse is to stitch the vulva with a needle and silk thread (Fig 4.6). This suture must be removed before kidding. This is not a difficult procedure and would be appropriate in many Third World situations.

7.4 Dystocia

Goats generally have few problems kidding but difficulties may arise if the kids are very large and get stuck or are presented incorrectly. Young goats giving birth for the first time or very small nannies are more likely to have problems. Some typical problems of presentation at birth are given below:

- one leg back
- head only
- forelegs only
- breech birth – hindlegs and tail
- twins or triplets mixed up.

As a guide goats should be assisted if:

- they have been straining heavily for over 45 minutes.
- kids are malpresented – one leg out only or head only out.

It is easier to help with malpresentations if an assistant is available. One person holds the nanny whilst the other helps the kids.

The assistant should hold the nanny on the ground on its right side whilst the goatkeeper kneels at the nanny's rear and uses his right arm to investigate inside. The ground should be swept clean and not wet. This person should have clean hands with trimmed fingernails. The hand and arm should be soaped with a good quality liquid soap or soapflakes (not detergent) or an obstetric lubricant. The inside of the vulva should also be lubricated.

A goat's cervix and uterus may be very small which makes insertion of an adult hand difficult. Excessive force must not be used. Sometimes a child or woman will have more success because of their smaller hands. If the kid is very large and will not pass through the cervix the goat should be taken straight to a veterinarian who may be able to deliver a live birth through a caesarian operation.

The legs can be pulled individually between thumb and first finger or

with a clean cord tied *above* the fetlock. When pulling cords or using hands pressure should be gentle and firm and in a downward curve as the kid comes out.

When assisting the kid's head this is best done by gripping, with the fingers, the side of the nose, behind the head or the eye sockets. A cord can be run around the top of the head behind the ears and pass either side of the face to join in front of the face to help pull the kid out. The lower jaw will break if it is pulled by itself.

When pulling a kid out pressure should be applied as the nanny strains. When pushing a leg or head back into the vagina this must be between strains.

All newly-born kids should have their navel painted with iodine or sprayed with an antibiotic spray to prevent diseases.

7.5 Kidding positions – malpresentations

1 *Normal position of single kid at birth*

If the kid is found in this position on examination (Fig 4.7a) the nanny should be left for 30–45 minutes. If there is no progress with the kidding process after this time the kid should be drawn out. This must be done firmly but gently by pulling both legs at the same time and ensuring the head follows.

Always check for more kids once the first is born.

2 *Head and one foreleg presented*

The leg which is not straight (Fig 4.7b) must be hooked forward using the index finger behind the knee and cupping the hoof in the palm of the hand whilst working it towards the front. The head and other foreleg may have to be pushed gently back into the uterus so that the malpresented leg can be reached.

3 *Head only presented*

The legs must be drawn forward one at a time (Fig 4.7c). The head may have to be pushed back each time.

4 *Forelegs only*

If two or more legs are presented (Fig 4.7d) check they are:

- from the same kid
- both front
- both back.

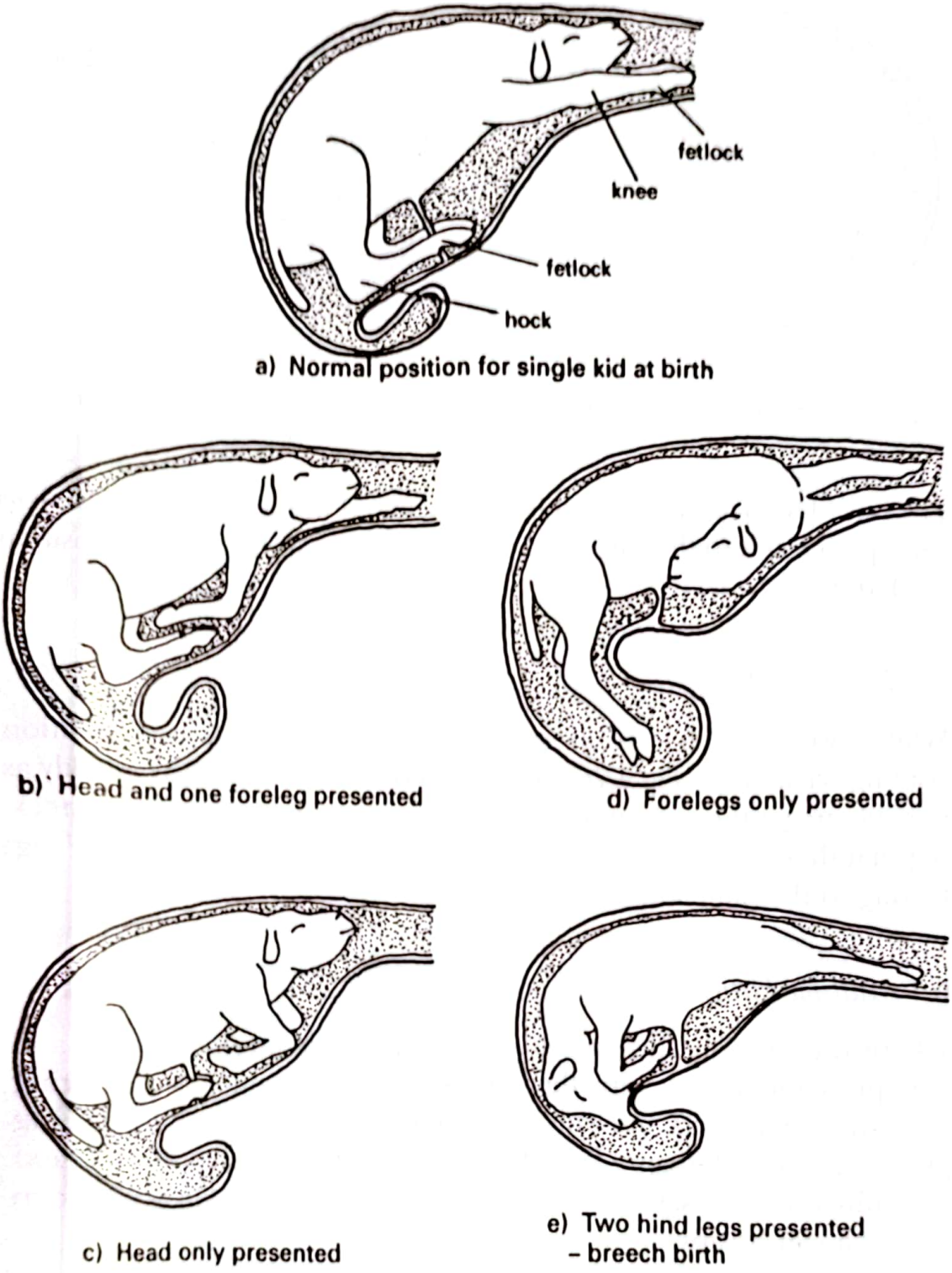


Fig 4.7 *Birth presentation*

This is done by tracing them back to the kid's body. Push back into the uterus any leg belonging to another kid and treat each kid separately.

Front legs hinge backwards from the kid's knee whilst rear legs hinge forwards.

If the legs are both front ones a clean cord should be tied around each leg above the fetlock. They are then pushed back into the uterus if

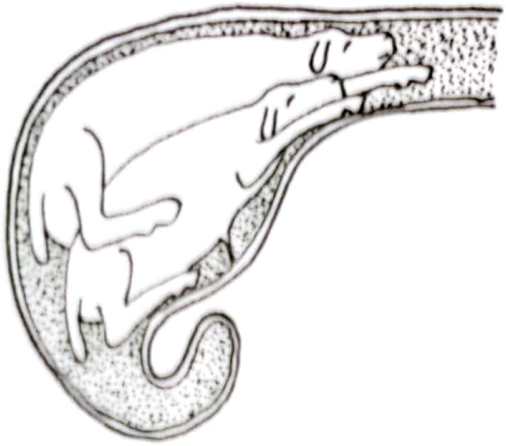


Fig 4.8 *Normal position for twins*

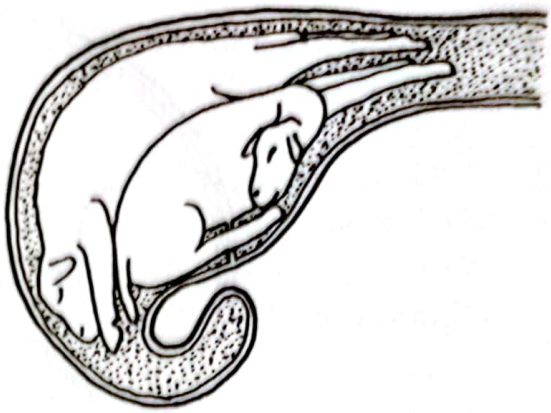


Fig 4.9 ***Malpresentation of twins***

possible. The head must then be manoeuvred to the front and the legs then pulled out so that they and the head will be in the normal position for kidding.

5 *Breech birth*

Where two hind legs are presented the kid is in the breech position coming backwards (Fig 4.7e). The kid should be delivered as quickly as possible to get the head into the air to enable breathing to start. Checking that there is a tail between the legs is a good indication that the legs belong to the same kid.

6 *Multiple births*

Where two or more kids are mixed up inside the uterus (Figs 4.8 and 4.9) push them back into the uterus. Then draw out the kid facing forward and nearest the vulva, making sure that the forelegs being pulled are from the same kid. Once out repeat the process for the next and subsequent kids. Clear the nose and mouth of each kid as it is born so that it can breath.

7.6 Kid revival

Place the kid in front of the nanny once it has been delivered so that it can lick the kid because this stimulates both mother and offspring. After difficult births the following measures should be taken.

1 Clean kid's mouth and nose of mucus and membranes, if the kid does not start breathing.
2 Check heartbeat by holding ribcage between finger and thumb just behind the forelegs.

3 If heartbeat is present tickle the kid's nostril with a blade of grass.
4 Rub the kid vigorously with some grass.
5 Hold the kid by the hind legs and gently swing it like a pendulum without dropping it!
6 If no heartbeat is found it may be possible to start the heart by gentle but sharp presses down on the rib cage.

Weak kids must be dried and given 25–50ml of colostrum. This can be milked from the mother or another recently kidded nanny. If a deep freeze is available colostrum can be kept in it for up to six months and thawed for use.

7.7 Useful kidding equipment

The following is the most useful equipment required for kidding:

- lubricant – obstetric fluid, soap flakes or good soap
- antiseptic
- iodine or antiseptic spray for navel
- 2 clean cords
- 2 or 3 prolapse retainers
- bucket and cloth
- syringes (5ml + 18g × 25mm)
  (20ml + 16g × 25mm)
- scissors or shears to clip hair
- penicillin or antibiotic injection
- 20% calcium borogluconate
- spare colostrum – in deep freeze, 60ml per bag
- reviver for stomach feeding (see below)
- torch for night kiddings
- box for carrying kid.

7.8 Stomach feeding

Kids that are weak and unable to suckle must be given colostrum with a stomach tube. An example is shown in Fig 4.10. These should be fabricated on the farm because most purchased revivers are for lambs and so are longer than needed for goats. Use the tube as follows:

1 Sterilize with boiling water.
2 Sit down and hold the kid across the knees with its head parallel to the ground.
3 Pass the tube over the back of the kid's tongue and push gently down the throat (oesphagus) and into the stomach.

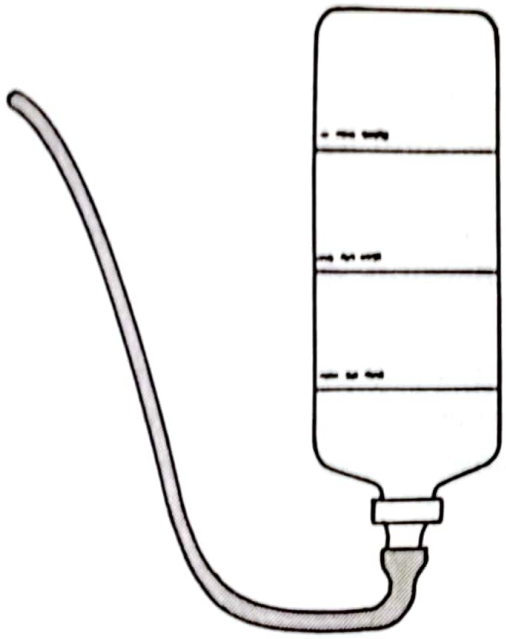


Fig 4.10 *Stomach tube*

4 Holding the receptical upwards get a helper to pour in the warm milk or colostrum. All liquids given should be at blood heat (to test pour on back of wrist, it should just not sting your skin)

Allow all the milk to drain into the stomach indicated by a gurgling from the receptacle. If the milk does not flow withdraw the pipe slightly.

5 Withdraw the pipe, clean and store the equipment.

8 *Management post-kidding*

Under extensive systems, the best policy is to disturb the herd as little as possible other than when difficulties are observed. Good supervision is essential. With intensive systems, it is important to separate out goats due to kid and put them in a clean, dry place free from disturbances. Such places need not be sophisticated because pregnant nannies and freshly kidded goats will usually remain in one spot. Pens should be regularly cleared of faeces and waste food and should have a supply of fresh water. The water should be in containers which cannot be overturned and into which young goats cannot fall. Unhygienic pens lead to problems such as coccidiosis and internal parasites. If a series of pens is available, the goatkeeper can isolate young or inexperienced females from the rest of the flock so they are protected from bullying or predatory animals or birds. Young kids should be encouraged to suckle and be carefully observed in their first few days to see that they are able to feed successfully.

8.1 Milk fever

After kidding the nanny may suffer from milk fever which can lead to death if untreated. Early symptoms include restlessness, loss of appetite, excitement and muscle trembling. Incoordination and coma follow. Animals will often sit with their head turned back and their eyes in a semi-conscious glaze.

A good recovery can be gained by early injection of 40 to 60cc of 20% calcium borogluconate solution under the skin in two or three sites (e.g. 20cc per site). The injection should be warmed to blood heat in advance by placing the filled syringe in freshly boiled water.

If a small amount of the syringe's contents are then squirted on to the back of the hand and this is not painful then the solution is not too hot.

9 *Kid rearing*

9.1 Castration (see also under health, chapter 5)

Castration is normally undertaken to prevent males mating and breeding. It will also avoid the taints and smells typically associated with the entire male should they be sold eventually for meat. Three methods are available:

- rubber rings
- burdizzo
- knife.

These methods are dealt with in chapter 6.

9.2 Disbudding

In some circumstances, it is worth de-horning or disbudding kids. This reduces the damage goats might cause each other when fighting and may help management when handling goats when dipping or weighing. Horns can, however, be very useful handles for restraining goats and as sites for identification marks.

The earlier the disbudding is done, the sooner the kid recovers. From 4 to 10 days is ideal. An electric, gas or fire-heated disbudding iron can be used. A sharpened water pipe works equally well. The following procedure should be carried out.

In the interests of the animal's welfare, an anaesthetic injection should be given. This should be given in advance so that there is enough time for the areas around the two horn buds to become numb so that the goat suffers no pain.

1 Whilst sitting, restrain the goat on your knees.
2 Clip away the hair around the horn bud.
3 Hold the head firmly, with ears under your hand.
4 Put a hot iron over the first bud and twist to cut skin at horn base.
5 Hold the iron on for 10 seconds only.
6 Check that a complete circle has been burnt around the horn. If not reapply for 3 seconds.
7 Remove the bud with thumb pressure.
8 Repeat for the second horn.
9 If bleeding occurs, apply the hot iron to cauterise (seal) the blood vessel.
10 Apply antiseptic powder to the wound and release the kid.

All kids need to be observed for shock immediately following disbudding. As male kids have double horns, a second site for each horn must be burnt. This is immediately in front of the first site and slightly towards the nose.

9.3 Moving kids and mothers

Kids are very difficult to handle or herd by themselves. They will run over walls, squeeze through gaps and run away. Kids are best herded with their mothers with much patience. They should be given time and space for individual families to stay together and negotiate obstacles. Moving small groups may be easier than one large flock.

9.4 Weaning

Weaning is the time when the kids and their mother are separated so milk can no longer be suckled. In some cases this does not involve physical separation because the mother's udder is sometimes covered with a cloth bag (Fig 4.11). Choosing when to wean is a compromise between kid growth and allowing the nanny to recover body condition for the next pregnancy. If weaning is carried out too early, kids remain small and prone to disease. If too late, the nanny's condition may decline so that she does not return to oestrus and so does not become pregnant again.

The kid must be able to eat solid foods before weaning. At birth a kid's rumen is not able to digest bulky fibrous foods such as grass. The kid's growth then depends entirely on the intake of milk, which is a highly nutritious and digestible food. The more milk a kid has available, the faster and larger it grows. Thus a single kid grows better than an individual twin and kids with a mother with lots of milk grow more quickly. Nannies kidding for the first time tend to have less milk than

Fig 4.11 *Nanny with udder bag*

older nannies. After two or three weeks the kids begin to nibble grass which helps their rumen to develop. At this stage they are usually drinking all the milk produced by the nanny. They also need access to clean, fresh water from this point.

Nannies often have multiple births and rearing more than one kid in most conditions is difficult. If one kid is smaller it may have less access to the udder or get left behind. The goatkeeper needs to make sure such kids receive adequate nutrition and it may be that they need extra feeding or fostering. After two or three months well grown kids are able to manage without their mother's milk and can be weaned. Smaller kids, those on poor milking nannies or those reared under extensive systems with poor diets, may take up to six months to reach the same stage. Immediately following weaning, kids tend to lose weight because of the stress of managing without a parent. They are particularly prone to ill-health or diseases at this point.

9.5 Fostering

If a nanny has more kids than she can feed it is possible to foster kids on to other nannies that are in milk. It is also worth transferring a kid to a nanny that has milk but whose kid has died. This will use the milk that she produces. The art of fostering is to trick the new mother into believing the kid is her own. This can be done by skinning the dead kid and placing the skin on the kid to be fostered. The nanny will then smell its old kid. The skin should be removed as soon as possible once the kid

has been accepted. The new mother and foster kid should be placed in a pen so they remain together.

It may be necessary to tie the nanny's head and also its back legs so that it cannot kick or butt the kid. The kid may need encouragement to feed.

9.6 Feeding in kid rearing

On extensive systems kids, once weaned, are left as a member of the flock where they grow slowly since the only food available to them is from grazing and a share of any feed provided. On more intensive systems kids may be reared on milk replacement using bottles or buckets. Milk can be made freely available (*ad libitum*) either cold or warm. In tropical conditions, adding acid to the milk prolongs the life of the milk so that kids can drink as required. In some temperate countries kids and lambs are fed on warm milk by automatic feeding machines. Such systems are, however, very expensive and profitable only where the value of the young is high.

Feeding young kids requires a good standard of hygiene, particularly in the cleaning of any feeding equipment involved. Failure to do so quickly leads to bacterial build-ups which can cause scouring, poor growth and possibly death.

Feeding milk made from powder can be undertaken at any stage after kidding as long as the kids receive adequate colostrum within the first few hours (maximum six) of birth. A very high level of management with constant supervision is required if very young kids are taken from their mothers. Such kids must be kept in small groups in clean, draught-free but airy pens.

At first young kids require training to feed from teats, either on bottles or in buckets. Kids may be fed three or four times a day. After three weeks kids can be allowed out into paddocks which have shelter, water and small amounts of forage and concentrates available.

10 *Common kid ailments*

Cold	In poor weather kids can quickly get cold and may die if not dried, warmed and fed.
Lack of food	If the kid is not feeding from the nanny check the teats are not blocked and that the udder has milk.
Bacterial scours	Kids very quickly succumb to conditions of poor hygiene and scour. These animals should be isolated from healthy kids and given a kaolin and antibiotic drench.

Accidents	Young kids can be fairly accident prone, falling into water troughs or being crushed. They are very susceptible to wetting and pneumonia. Following sudden changes in the weather, very young kids may huddle in corners on top of each other and be smothered.
Enterotoxaemia	If nannies are not vaccinated kids can contract enterotoxaemia (pulpy kidney) at 4–6 weeks of age. The kids will scour, not feed, appear dazed and suffer pain and convulsions with death commonly occurring.
Worms	Once kids start grazing they are susceptible to internal parasites and should be drenched regularly.
Coccidiosis	In dirty, cramped conditions coccidiosis can cause diarrhoea and death. All kids should be treated with sulphonamides and moved to cleaner conditions if this occurs.
Infected navel	Kids born into dirty conditions may contract joint ill through the broken umbilical cord. It is important to dress the navel with iodine or antibiotic spray at birth to prevent this.
Mineral deficiency	As with adults, kids require access to a mineral lick or a mineral block to avoid deficiencies that may lead to poor growth.

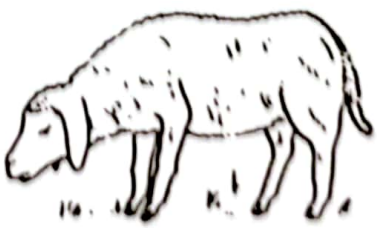
10.1 Identifying healthy and unhealthy kids

Kids at birth

1 Healthy

- Active and alert
- Up on feet in 30–60 mins
- Breathing normal.

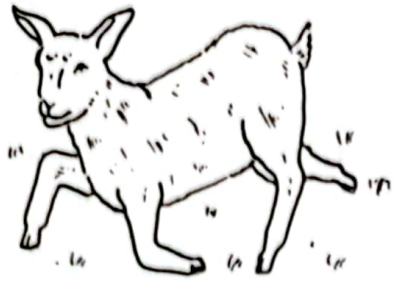
2 Unhealthy



- Unwilling to move or feed
- Weak and cold.

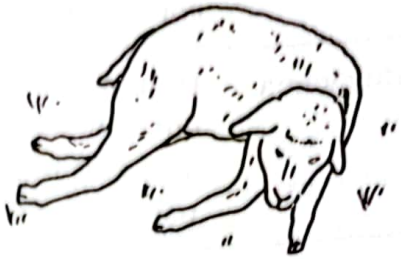
First week

3 Healthy



- Moves freely
- Feeds often
- Active and alert.

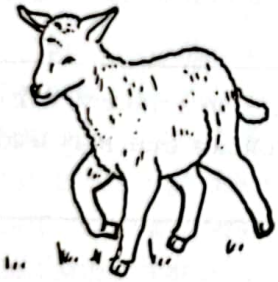
4 Unhealthy



- Hunched up
- Cold and lethargic.

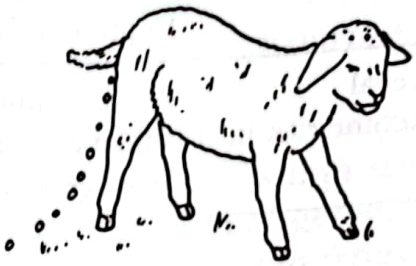
Older kids

5 Healthy



- Active and playful
- Feed often
- Smooth bright coat
- No digestive upsets
- Moves with flock.

6 Unhealthy



- Separate from flock
- In pain
- Scouring
- Moves slowly, lame.

5 Health

Goats in the tropics are hardy, adaptable animals which show a high resistance to diseases. They are able to manage in environments of changing climate and fluctuating food supplies including zones in which sheep and cattle would not easily survive. However, once actually ill, goats may quickly decline and die. Prevention of diseases is, therefore, very important for the goatkeeper.

Healthy goats are both easy to manage and productive. Whilst dead and dying goats clearly represent losses, a larger economic loss occurs through goats having chronic problems that mean they do not breed or grow to optimum levels. Internal parasites are just one example.

1 *Factors affecting health*

A number of factors affect the health of the goat, the most important of which are feeding and general management. Others include:

- intensity of production
- age of animals
- breed
- weather/climate
- contact with other animals.

Animals which have continuous access to good quality food are less likely to become ill. Under intensive systems where many animals are reared together, disease problems quickly become more acute because of the rapid spread of diseases among animals which are in close contact with each other. Managers of such units can reduce the animals' susceptibility to disease by reducing stress from bullying and overcrowding. All animals need adequate access to food and water troughs and shelter. Younger and very old animals are more susceptible to diseases and parasites than mature animals. The first three weeks, and particularly the first 24 hours and immediately after weaning, are very critical periods for kids. Towards the end of a lactation, nannies in poor condition may also be prone to disease challenges, especially where this coincides with the end of the dry season and beginning of the early rains.

2 Healthy goats

It is important that the flock manager recognises early symptoms of disease in order to take remedial action or seek veterinary assistance. The healthy goat is typified (Fig 5.1) by:

- a good appetite
- being bright, alert and responsive, playing and climbing
- staying with the flock
- a smooth, clean shiny coat
- clear eyes with some pink colour in the eyelids
- an erect tail
- a moist nose.

An unhealthy goat (Fig 5.2) may show:

- reduced appetite or no cudding
- sitting or lying down away from the flock
- a hunched-up stance
- ears down and/or cold
- tail down
- dry nose or discharges from the nose, eyes or mouth
- a dull matted coat
- fast or slow breathing.

Symptoms of ill health may appear gradually so the goatkeeper must be particularly regular in checking for out of the ordinary characteristics or behaviour. Such chronic symptoms may indicate an underlying problem such as internal parasites. More acute symptoms such as those of rapid breathing and nasal discharges which indicate pneumonia are more obvious and require rapid treatment. Occasionally animals may be found dead with no previous indication of illness, as with anthrax.

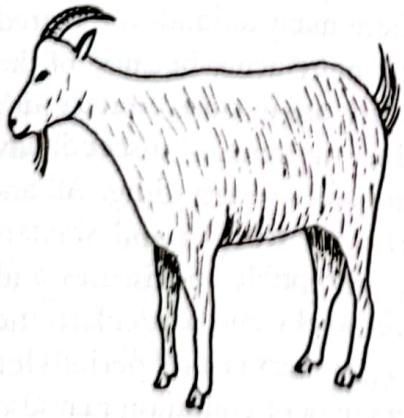


Fig 5.1 *Healthy goat*

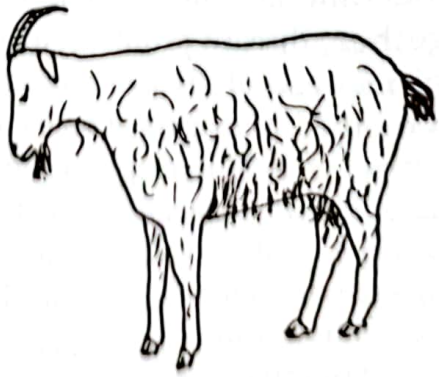


Fig 5.2 *Unhealthy goat*

3 Control of diseases – precautions

Prevention of diseases is much more effective than trying to cure sick animals. The goatkeeper can do a great deal through good husbandry to avoid his flock becoming sick. If he understands the main diseases facing his flock he can take steps to lower the impact of these problems.

Many diseases can be vaccinated against. These include clostridial diseases like pulpy kidney, enterotoxaemia and blackleg, also orf, and foot-and-mouth disease.

Good management practices can be vital. These can include the provision of clean water, unpolluted feedstuffs, minerals or trace elements. Maintaining clean housing and grazing that reduces parasite and disease build-ups and the regular treatment of stock with anthelmintics will reduce disease challenges.

3.1 Housing and feeding (see also chapter 6)

Housing that is easily cleaned, well ventilated and that allows sunlight to dry and kill disease organisms in dung or urine is preferred to warm, wet and airless conditions.

Goats are fussy eaters and will waste food by pulling it from racks to the ground and spoiling it. They will also jump into racks and contaminate forage.

3.2 Drenching and dipping (see also chapter 6)

Where animals are kept in intensive conditions the build-up of parasites is likely to be rapid and large. Goats in these conditions need regular treatment with effective anthelmintics to reduce worm burdens. The same approach is required with external parasites such as ticks, lice and flies. Regular dipping or spraying of animals to reduce these parasites is needed.

3.3 Contact with other or ill animals

A flock should avoid prolonged contact with other groups of animals especially those from outside the area or those containing sick animals. This will reduce the risk of diseases being transmitted directly between animals such as occurs with diseases like pneumonia. Markets and watering points are places where it is difficult to avoid animals mixing.

3.4 Sick animals

Ideally, sick animals should be removed from the flock as soon as disease

symptoms appear and should be treated. If the goatkeeper is not sure what the problem is advice should be sought immediately from a vet if available.

The art of a good stockman is knowing when to seek help.

3.5 Quarantine

If new goats are brought in it is wise to keep them separated from the established flock for a period of quarantine to observe any signs of disease. These new animals should be housed, fed and watered separately and the goatkeeper must avoid transferring diseases between animals. He should clean his feet and hands before and after working with the new goats.

4 *First aid*

If you have a goat that has a bleeding wound, a broken leg or is choking you should quickly

1 Restrain it to prevent further injury.
2 Check the extent of the injuries.
3 Decide on a course of action.

Severely injured goats that are not diseased and will not recover can be slaughtered for immediate consumption, i.e. following a car accident. If an animal is found dead and the cause of death is unknown it should not be eaten nor other animals allowed near it. It should be buried or burnt.

4.1 Bleeding and wounds

Bleeding can be stopped by applying pressure to the wound. A clean piece of towel or sheet is placed on the wound with a larger pad pressed on top. This can then be bandaged in place.

If an artery is cut then blood will pump from the cut. Press the fingers on to the artery. It may take several minutes to stop the blood flow. For a leg wound twist a piece of cloth around the leg nearer the body than the cut and tighten to restrict the blood flow. This is a *torniquet*. For a big wound the damaged area must be stitched up. Smaller cuts will repair if cleaned with fresh water, treated with an antiseptic or sulphur wound dressing and bandaged up.

4.2 Broken legs

If the goat suffers a broken leg, immobilise the leg as far as possible by

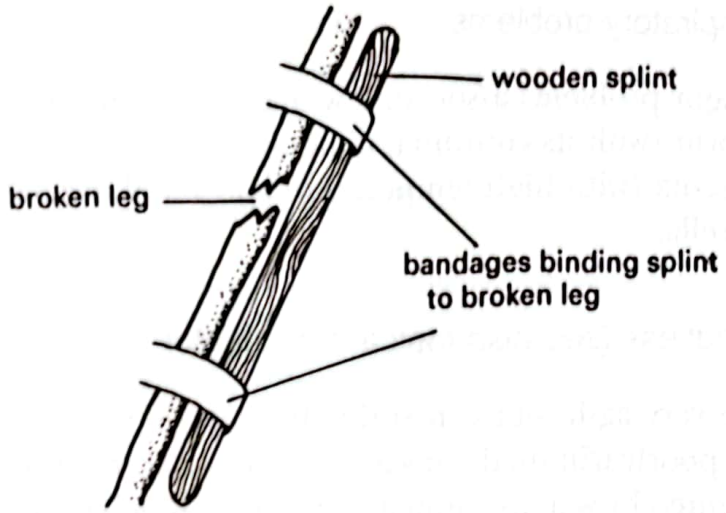


Fig 5.3 *Splinting a broken leg*

bandaging a wooden splint to it (Fig 5.3). Such bandaging must be firm but not so tight that blood is restricted. Breaks with young kids are common as they get trapped in fences, trees and other obstacles. They also mend very quickly and if set correctly will not have a limp.

4.3 Choking

Goats are inquisitive feeders and will eat anything left around! Some objects may get caught in the throat or oesophagus and cause distress, coughing or choking. If the obstruction is not visible and so cannot be easily removed, get helpers to hold the goat up off the ground by its back legs and slap it on its back. If this fails, a trip to the vet is required.

5 *General husbandry*

Regular observation of goats greatly helps with early treatment of problems. A number of general rules can be adopted.

5.1 Scouring

If goats start scouring prompt treatment to replace body fluids is needed. Water with glucose and mineral salts added should be given. The cause of the scouring must also be identified and treated with drugs. Roughages and browse should be given but not concentrates which will make the scouring worse.

If worms or coccidiosis are the problem the whole flock should be treated. Very sick animals should be isolated from healthy ones.

5.2 Respiratory problems

Three major problems associated with respiration are:

- lungworm (with its continual coughing)
- pneumonia (with high temperature and nasal discharge)
- pasteurella.

5.3 Lameness (see also footcare in chapter 6)

Goats are very agile but can suffer from poor feet including foot rot, laminitis, poorly trimmed nails and foot injuries. Foot rot can be treated and prevented by walking animals through a foot bath with a 10 per cent solution of zinc sulphate or formalin. Foot rot is more severe in wet conditions that might occur in the rainy season or in marshy areas. As foot rot is infectious goats suffering the condition should be isolated.

5.4 Eye, nose and mouth

Goats suffer *pink eye* which is a clouding over of the eye that produces a sticky discharge. The eye closes and blindness results if left untreated. Antibiotic eye cream given for a three-day period will effect a rapid recovery.

5.5 Feeding and poisoning

Poor feeding practices can upset the goat's digestion. Overfeeding of grains or lush green grass can lead to an impacted rumen, enterotoxaemia and bloat. Bloat can be treated by removing the goat from the food source immediately, drenching with liquid paraffin (kerosene) or cooking oil and walking the animals around. Enterotoxaemia should be vaccinated against if it is a frequent problem.

Goats are opportunistic feeders but usually avoid poisonous plants and trees. A good goatkeeper will also keep his flock away from known problems. Goats will, however, raid rubbish heaps and other human debris. If they are stall fed and the diet contains bracken, hemlock, tomato haulm, yew, or some varieties of cassava, death may result. If poisoning occurs a first measure is to give one tablespoonful of baking powder in warm water followed by 300–500ml of paraffin oil. Help from a vet should then be sought immediately.

5.6 Taking temperatures

The body temperature of the goat is a very good indicator of its health and should be 102°F (101°–103°F) or 39.0°C (38.5°–39.5°C). The body

temperature will fluctuate daily and seasonally, especially if air temperatures are high as in arid areas.

A normal clinical thermometer can be used to check a sick goat's temperature in the following way:

1 Shake the thermometer to get the mercury inside to the bottom of the scale.
2 Lubricate the bulb end of the thermometer with vaseline or spit.
3 With an assistant holding the goat in a standing position insert the thermometer, bulb first, 2cm into the rectum.
4 Leave in for 2 minutes then remove and read mercury on scale.
5 Shake thermometer again, wash in water (not hot), dry and store carefully.

5.7 Parasites – external

Goats are liable to become infected with external parasites, especially if they have hairy coats. Ticks, fly larvae, lice and mites can all be troublesome. These are picked up from bushes and housing areas by the hairs of the coat.

Ticks

These are picked up during grazing and attach themselves to the area around the head or ears. The ticks swell up to pea size as they suck the goat's blood. This causes irritation and encourages flies which can bring infection. Ticks can also carry diseases like heartwater that cause low productivity or death. For small numbers of animals it is feasible to remove ticks by pulling or carefully burning them off individually. For larger numbers dipping or spraying with insecticide is needed on a regular timescale.

Lice and mites

Mites and lice will occasionally infest goats causing irritation, dandruff and hairloss. Goats will rub against posts and trees. Mites cause sarcoptic mange which is controlled by applying sulphur dust or spraying insecticide. Both sucking and biting lice are best killed by sprinkling powder that contains insecticide along the back.

Lice are species specific. As lice and mites live on goats all their lives, infestations are only spread by close contact between goats.

Flies

Blow flies bite goats and lay eggs usually in matted dirty areas or wounds

around the vagina and rectum. These eggs develop into larvae which bore into the skin causing very unpleasant wounds which the goat, in its intense irritation, will try to bite or rub. Larvae are killed with liquid insecticide or dusting on fly strike powder. Rapid healing of the wounds and keeping the goat's coat clean will prevent further attacks.

5.8 Internal parasites (Helminths)

These cause very serious problems for goats which appear to have less resistance to parasite challenges than sheep. A regular programme of drenching is important, especially where many goats are kept, to maintain them in good health and so productive. The most common helminths are *roundworms*, *tapeworms* and *liverfluke*.

A typical life cycle of a helminth is shown in Fig 5.4. The infected goats pass eggs, laid by the adult worms, in their dung. These eggs hatch, on the pasture, into infective larvae. Goats ingest these larvae as they graze. Once in the stomach the larvae develop into adult egg-laying roundworms and the cycle begins again.

The humid tropics are ideal places for the high production of larvae because of the rainfall and humidity. In more arid areas roundworms can be much less of a problem as high temperatures on the pastures kill both eggs and larvae.

Young kids are very susceptible to roundworm infestations while healthy, well-fed adults can manage infestations until they are stressed or sick from other causes. They then lose physical condition, so that growth and reproduction are reduced.

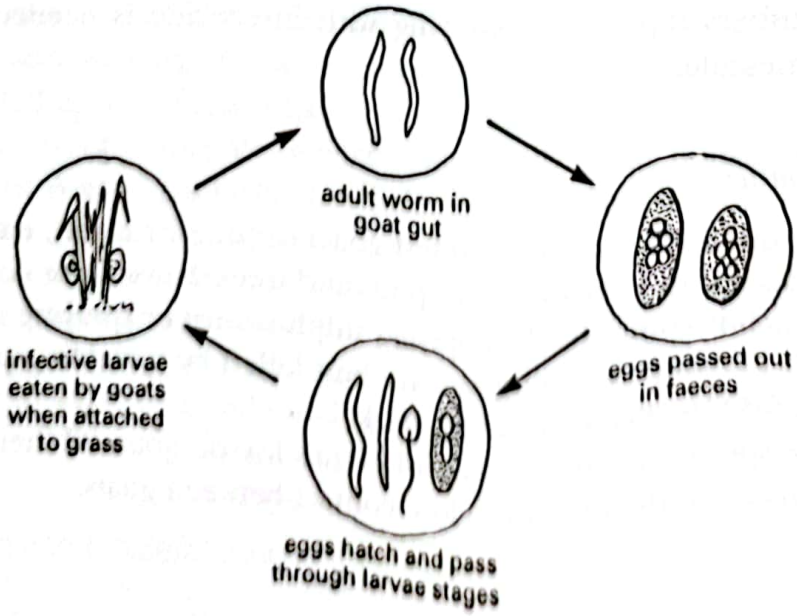


Fig 5.4 *Life cycle of a helminth*

Roundworms

The most common and serious roundworm is called *Haemonchos contortus.* Where stocking densities are high losses will occur. The pattern of grazing can help reduce infestations and losses. Rotational grazing, where the animals are grazed on one particular pasture and then moved to an ungrazed or clean area or those stocked by cattle which do not carry the same worms, will reduce the worm impact. Keeping the goats away from the original pasture for 10–21 days will dramatically reduce the number of larvae on the grass as they will soon die as no goats are present to allow the worms to continue their life cycle. After this time the goats can graze the area again. As sheep carry the same worm as goats, areas grazed by sheep do not produce clean worm-free areas. Grazing goats on the land after crops have been harvested is also a good way of lowering worm burdens.

Roundworms can be controlled by dosing with chemicals called anthelmintics. Both modern and traditional anthelmintics are used. The former are safer but more expensive. For the best results goats should be moved to clean pastures once dosed.

Tapeworms

The life cycle of several tapeworm species that affect the goat involves dogs as hosts. The adult worm lives in the dog and the larvae in the goat. These larvae damage the brain and spinal cord as they burrow about. As the larvae can get to be an adult worm only if a dog eats the goat meat in which they have burrowed, the cycle can be stopped by preventing dogs eating goat carcasses.

Liver fluke

Two flukes, *Fasciola gigantica* and *fasciola hepatica,* live in the liver of both sheep and goats and can cause ill health and death. The immature flukes damage the liver as they move. Fluke is most commonly associated with damp, warm conditions because they need snails to complete their life cycle and these require a moist environment in which to live. Eggs from the mature fasciola hatch into a free-living form called a miracidia which penetrates the snail from where cercaria migrate to the grass eaten by goats. Severe infestations will lead to fatalities whilst all infected animals will show anaemia and wasting. Poorly-fed goats are most at risk so deaths at the end of the dry season are typical. Separating goats from the snail habitats would prevent infestations but this is very difficult as snails are apt to live at drinking points. Fencing would help but is often too

expensive. Clearing vegetation, including aquatic vegetation, from watering places reduces the number of snails.

Typical symptoms of helminth infestations are:

- anaemia (pale eyes and gums)
- scouring
- loss of condition
- swelling under the jaw
- quickly tiring
- coughing (lungworm – see below).

Lungworms

These worms are found in the lungs of sheep and goats and animals affected have a continuing distinctive cough. Young goats in their first summer or wet season are very susceptible and the problem is severe in the Middle East and cool tropics. Goats that survive become immune to reinfection. Modern anthelmintics are very effective.

6 *Common diseases*

6.1 Coccidia

Coccidiosis is a protozoal disease found in young animals kept under intensive systems. The protozoa live in the intestines and cause anaemia, a foul diarrhoea and emaciation. Sick goats should be removed from areas contaminated with dung, isolated and carefully nursed using sulphur drugs (sulphurmezathine or sulphaquinoxaline) or antibiotics.

6.2 Trypanosomiasis

Tsetse flies are responsible for transmitting the disease trypanosomiasis. Goats native to areas infested with tsetse are usually tolerant of the disease but exotic goats are very susceptible when introduced.

6.3 Anaplasmosis

This is transmitted by ticks and occasionally biting flies. Cattle are more affected than goats and the older the goat the more severe the consequences. Anaemia and poor productivity is more common than death which is often related to poor nursing. Given early enough, antibiotics can help.

6.4 Anthrax

Anthrax is characterised by fever or more usually sudden death. This is true for all ruminants but especially goats. It can be fatal to man. Animals that are found dead with no obvious cause must be burnt or buried and not eaten. Prevention of the disease is by an annual vaccination.

6.5 Bloat

Bloat occurs when gases build up in the rumen and cause pressure on the diaphragm. If these are not released death can result through asphyxia and shock. The goat would normally belch to expel excess gases but this may be restricted due to an obstruction, paralysis of the rumen wall muscles or from excess foaming of the digestive contents.

One of the commonest causes of bloat with goats is from eating large amounts of strange food that is high in energy, from scavenging through rubbish or being given rotten, left-over food.

The first signs of bloat include:

- loss of appetite
- discomfort
- swollen abdomen (high left side)
- shallow laboured breathing.

Treatment may include:

1. Removal of any obvious physical obstruction in the throat.
2. Drenching with 150–250ml vegetable oil, warm butter or 10ml pure turpentine shaken in a little hot water.
3. Walking the goat about to induce belching or flatulence.
4. As a last resort the gases can be released by stabbing the rumen. A very sharp and thin knife or wide bore needle can be used. A spot on the animals left side immediately behind the last rib is ideal. On a distended rumen the most prominent part of the bulge is chosen.

6.6 Brucellosis

This disease is caused by *Brucella Melitensis* and is potentially very serious for humans as it may lead to undulant fever and sterility. It is carried in the milk of goats but destroyed by boiling.

Symptoms include abortion in late pregnancy, mastitis, coughing and poor condition. Deaths occur occasionally. Sheep are more resistent to brucellosis than goats but goats seldom abort more than once.

Vaccination will prevent brucellosis although good hygiene is essential in a disease outbreak.

6.7 Enterotoxaemia

This is a common problem in goats which can cause death within 36 hours. Early signs include loss of appetite, bloody diarrhoea and convulsions. In mild cases animals recover naturally within 7 to 10 days. This disease originates from clostridial organisms that live naturally in the soil and the gut. They only become a danger when the normal feeding pattern of the goat is upset, such as when infected food or large amounts of a strange food (e.g. cereals) is eaten. Then the clostridia will produce toxins which poison the goat.

Avoiding sudden changes to a diet will reduce the risk of enterotoxaemia and vaccinating nannies one month prior to kidding or the young kids will successfully prevent the problem. However, treatment often fails.

6.8 Foot-and-mouth

This is a very infectious disease caused by one of seven viruses whose distribution varies throughout the world. Goats, sheep and cattle are all affected. Infection causes poor growth and lameness rather than deaths. Most goats recover and then are immune to the particular virus that attacked them. Common symptoms include sores on the mouth and between the hooves, loss of appetite and occasionally abortions and death.

Foot-and-mouth spreads both by direct contact and through the air over short distances.

Vaccination campaigns every six months can control the disease. Countries free of foot-and-mouth maintain this status by restricting imports and the movement of animals.

6.9 Foot rot (see also care of feet and lameness in chapter 6)

This infectious bacterial condition causes decay under the hoof, with a distinctive smell. Goats go lame and lose condition. These should be isolated and treated to prevent the disease spreading. Treatment involves trimming the feet of the diseased areas and applying a tincture or antibiotic ointment.

Grazing animals in damp and swampy pastures will promote foot rot whilst prevention is achieved by running the whole flock through a foot bath of a 10 per cent solution of either copper sulphate or zinc sulphate. Keeping the goats' hooves trimmed by regular cutting or walking them daily over a hard surface like a road will prevent overgrown hooves which encourage foot rot.

6.10 Joint ill

Also called navel ill, this is a disease that kids get when bacteria enters through the umbilical cord and navel or through a wound. It is most common in kids that are born and reared in poor, unhygienic housing. If infected the joints swell and animals walk very stiffly. Death can follow. If treated promptly with antibiotics kids recover quickly but prevention is a much better policy. The navel of new-born kids should be dipped in iodine or covered with an antibiotic spray and kidding areas must be regularly cleared of droppings and soiled material.

6.11 Mastitis

This is a condition in which the udder of the lactating nanny becomes hard, swollen and sore. Any milk produced is watery with white lumps in it. Blood may also appear. Mastitis is caused by a build-up of bacteria, normally in the udder. Goats most commonly suffer attacks of mastitis at the beginning of a lactation or at weaning. A high-yielding nanny may have to be hand milked on a declining plane for a short period after weaning to avoid a sudden halt to suckling which can trigger mastitis. Nannies' udders should be checked regularly after kidding, following the death of a kid and after weaning.

6.12 Pneumonia

Goats do not like getting wet and chilled. They are very susceptible to pneumonia which is a major cause of death in flocks. Various agents are responsible for pneumonia, which is normally spread through droplet inhalation and direct animal contact. Typical symptoms progress through difficulty in breathing, discharges from nose and mouth, a disinterest in eating and drinking, heavy, laboured breathing and eventually death.

Contagious Caprine Pleuro-Pnuemonia (CCPP) is a form of pneumonia that is widespread in the tropics. It is very serious with mortality rates of 60 to 100 per cent. Prevention is achieved through avoiding contact with infected animals and cold, wet conditions.

Pneumonia Pasteurellosis (PP) is similar to CCPP but its incidence is often related to stress such as that associated with transporting goats.

Peste des petits ruminants (PPR) or Pseudo-Rinderpest is also a major virus infection for goats in the tropics. The symptoms are like those of

rinderpest in cattle with high fever, catarrh, nasal discharges and diarrhoea. Mortality is very high, with most deaths occurring within seven days. Survivors are immune.

Goats often die from secondary infections that lead to pneumonia. Treatment is ineffective and prevention is a matter of avoiding contact with sick animals. A vaccine is under development.

6.13 Pregnancy toxaemia (ketosis)

This condition occurs in the last period of pregnancy in females carrying more than one kid and being poorly fed. The nanny diverts nutrients to her foetuses to the detriment of herself. If the condition is not prevented or corrected very early the goat will die. The symptoms start with the goat losing condition, lagging behind the flock, falling down, being unable to rise, glazed eyes, paddling legs and death. A distinctive smell from the nanny's breath is characteristic.

Treatment is not very effective but consists of giving 200ml glycerol drenches twice daily or intravenous glucose. Prevention is by giving pregnant nannies sufficient but not excessive nutrition. Additional concentrates or high quality fibre may be needed, especially in the last part of pregnancy, so that there are enough nutrients for both the nanny and the kids.

Pregnancy toxaemia is not common in traditional grazing systems.

6.14 Goat pox (Dermatitis)

Like sheep pox this is a virus which causes fever and nodular blisters on the mouth, nose, udder and between the hind legs. It is very irritating to the goat. The blisters may turn into ulcers but will eventually form crusts that drop off leaving permanent scars. Deaths from goat pox do occur but most animals will recover. Goat pox is transmitted by direct contact or by insects. Vaccination is the only effective method of control. As humans can get goat pox care must be taken to avoid handling the infected areas directly.

6.15 Streptotrichosis (Dermatophilosis)

Goats affected by this disease show lesions around the face and ears. These weep and mat the hair. Scabs then form which eventually lift off but stay attached to the hair. If the scabs are removed the wounds can be treated with antibiotic sprays or dust. Injections of penicillin will also cure cases. The disease starts when bacteria enter damaged skin. As transmission is by direct contact and by ticks and flies, control can be achieved by providing shelter against the wet and treating against flies

and ticks. Avoiding goats damaging themselves on thorny plants is also important.

6.16 Tetanus

This is also known as lockjaw and is caused by *Clostridium tetani* which is a bacteria commonly found in faeces and soil. It enters through damaged skin such as may be caused by castration, shearing or dehorning. Once in the body, *Clostridium tetani* produces a toxin which causes a range of symptoms. These start with stiffness (hence lockjaw) and anxiety, progress to muscular spasms which lead to respiratory arrest and death. It is impossible to keep goats away from soil but cleaning living areas free from faeces will help prevent tetanus. Vaccination is the best course and it is worth the goatkeeper and his family also being vaccinated against what is a dangerous disease in humans.

7 *Vaccinations and injections*

Many major diseases that threaten goats can be prevented by vaccination. Goats can thus be protected against many diseases (e.g. clostridial diseases like tetanus and enterotoxaemia) by injecting a small amount of the agent that causes the disease but whose virulence has been reduced or destroyed. Introduction of this agent into the body induces the immune system to develop antibodies that are thereafter immediately ready to fight the real disease. Vaccination therefore gives the goat an early warning against disease threats.

Goats are normally injected twice initially and then given a booster injection on a regular cycle of 6 or 12 months.

Unborn kids can be protected by vaccinating the pregnant nanny during the last month of pregnancy. Antibodies then develop in the foetus before it is born so that it has resistance to diseases at birth.

Table 5.1 A typical vaccination programme

	Time of injections			
	1st	2nd	3rd	over 3
Kids from unvaccinated nanny	Week 2	Week 6	Week 10	6 monthly
Unvaccinated goatlings	2 doses 4 weeks apart then 6 monthly			
Pregnant nannies	3 weeks before kidding			
Bucks	2 initial doses then 6 monthly			

For details of how to inject see *Injecting goats* (page 90). The normal site for vaccinations is under the skin (subcutaneous) on the side of the neck 75cm behind and below the ear. The area should be clean and dry and the needle must not be pushed too deep in case an abscess results which can attract flies. Vaccines may have to be kept cool or made up from a dry powder. All will have expiry dates after which their effectiveness falls. Ideally they should be used before this date and bottles should be fully used up once opened or surpluses safely thrown away. The correct dose, which may vary with the size of goat, must always be used. Needles should be changed every 20–30 animals as they get blunt and dirty. Goatkeepers should take care not to inject themselves accidentally as some vaccines can affect humans.

6 Routine husbandry

The maintenance of a good standard of animal husbandry through good management practices is very important for efficiency and profitability to be achieved. The traditional farmer keeping goats under an extensive system understands his environment so that he can manage his flock well. He and his flock select grazing, shade and water as well as avoiding physical and health dangers. When the flock is confined under more intensive conditions the flock is less able to manage itself and a heavier managerial load falls on the goatkeeper's abilities.

1 *Determining the age of a goat*

The age of a goat can be estimated by looking at its front (incisor) teeth. The goat is restrained by standing with your legs astride it. The teeth can then be inspected by gently pulling the head back and opening the mouth with the thumb and forefinger. Only the bottom jaw has teeth. (See Table 6.1 and Fig 6.1.)

Older goats lose or have worn teeth which causes them difficulty in eating and so they will lose condition and breed less well than younger animals or become more prone to diseases. Inspecting the teeth can be

Table 6.1 Goats' teeth

Kid	Under 1 year	Eight sharp incisors
Yearling	1–2 years	Central pair of baby teeth replaced by permanent ones
Young adult	2–3 years	4 permanent teeth
Adult	3–4 years	6 permanent teeth
Adult	4–5 years	8 permanent teeth
Older adults	Over 5 years	Worn teeth and some missing

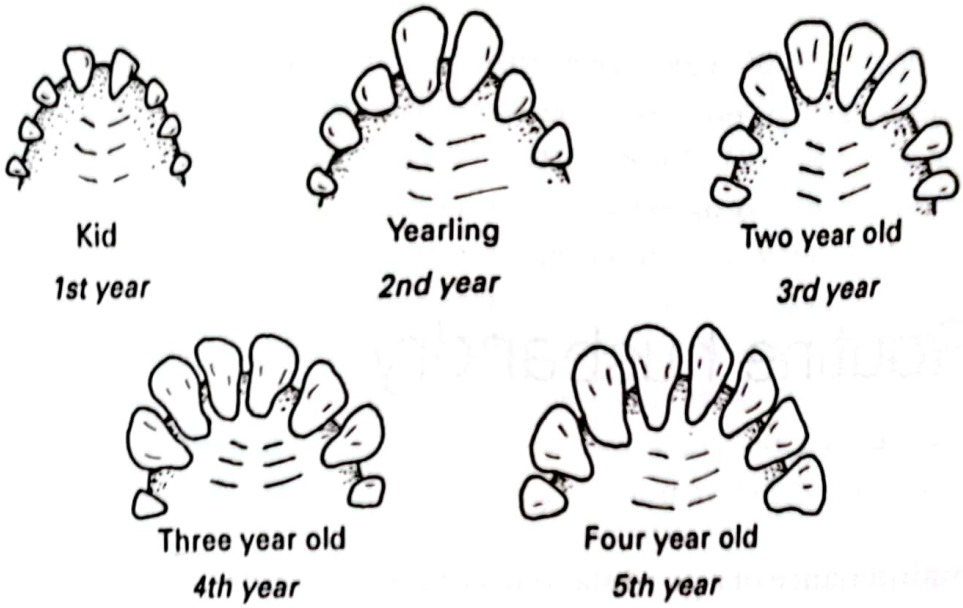


Fig 6.1 *Goats' teeth*

a very useful way of deciding when to discard or cull an animal and replace it with a healthier younger goat.

2 *Weighing goats*

The regular weighing of goats is uncommon in the tropics except on research stations. It can, however, be very helpful in selecting stock for breeding or for sale. For example, when a young female reaches 75 per cent of the average adult body weight it is at its most efficient size for mating. There are three methods for weighing:

2.1 The weighband

This is a simple tape measure that predicts the liveweight of an animal from measuring its girth. The band can be made from a piece of string which is marked off in kilograms. It should be calibrated against a spring or platform scale for accuracy because there are differences between breeds. When using the band the goat must be standing on level ground. The string is then run under the animal, behind its front legs and up to the top of its shoulders.

2.2 Platform scales

Commercially available scales are usually designed for sheep but in most cases can be used for goats. Even animals with large horns will learn to negotiate entry if weighed often enough. The scales are built like a thin

cage with doors at each end and a clock scale on top. For large numbers of animals it is useful to have a holding pen that funnels the animals into the scale. Care must be taken to see that goats have all four feet on the floor of the cage when they are weighed, that the measuring indicator returns to zero after each animal leaves and that the scales are kept clean. This will help to ensure accurate weighings.

2.3 Spring balance

This consists of a commercial scale with a hook from which goats can be suspended in a sling. The scale needs to be hung from a height so that all the animal is freely suspended. For small goats the handler may be able to hold up the scales and animal. In general, however, a tripod or strong branch of a tree is necessary.

The goat is lifted into a comfortable cradle or set of straps which is then hooked on the scale. Once the goat is still and all four feet are clear of the ground the weight can be read. Then the animal is lifted down.

With all three methods each goat needs to be identified so that it can easily be found later on or so that recordings over a period of time can be compared. The whole weighing operation is made simpler if an assistant is available to help. It is particularly important to keep any recording sheets away from hungry goats! Enough room must also be available to ensure a swift flow of work.

3 *Body scoring*

As well as examining goats to assess their physical condition it is useful to feel along their backs to assess their body condition. A system of assessing the body condition of sheep has been developed in Australia and is widely used in a number of temperate countries. It can be used on goats to give a good indication of body condition but because goats have very little body fat under the skin this system really gives an estimate of the goat's muscle cover. The fingers and thumb are used, as in Figs 6.2, 6.3 and 6.4, at three points on the goat's back whilst the animal is held in a standing position.

3.1 Spinous processes

Feel for the spinous processes in the centre of the goat's back behind its last rib and in front of its hip bone.

- Are the tips sharp or rounded?
- Is the ridge of the spine above the level of the muscle?
- Is the spine at the bottom of a little hollow?

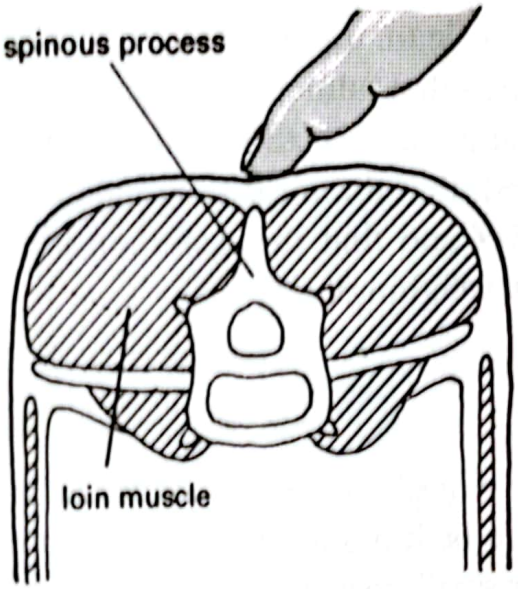


Fig 6.2 *Spinous process*

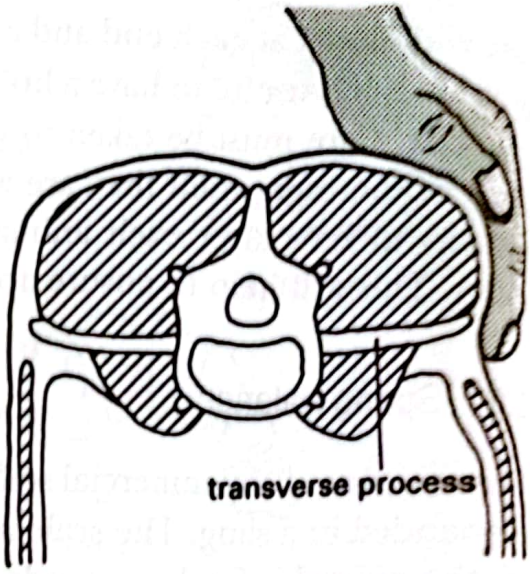


Fig 6.3 *Transverse process*

3.2 Transverse process

Feel for the tips of the transverse process.

- Is it sharp or smoothly rounded?
- How far will the tips of your fingers go under the transverse processes?

3.3 Loin muscle

Feel the muscle on either side of the backbone between the spinous and transverse process.

- Are the loin muscles shallow, moderate or full?

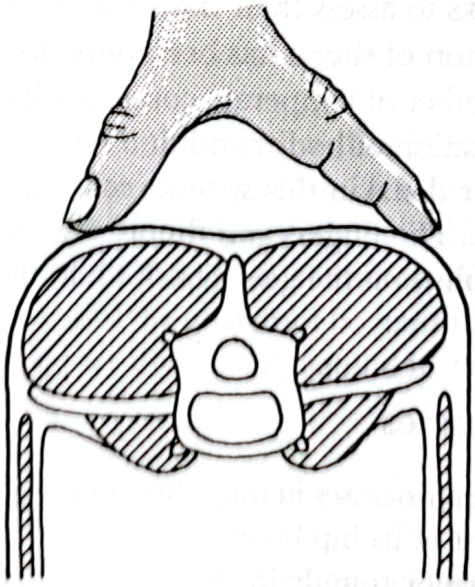


Fig 6.4 *Loin muscle*

Condition score 0	Extremely thin; nearly dead; no muscle between skin and bone.
Condition score 1	Spinous processes are sharp and stick up. Transverse processes are sharp and your fingers easily push under their ends. There is a hollow between the end of each process. Loin muscles are shallow.
Condition score 2	Spinous processes feel less sharp; your fingers can be pushed under the transverse processes with a little pressure. Loin muscles are of moderate depth.
Condition score 3	Spinous processes only stick up very slightly; they are smooth and rounded. Firm pressure is needed to detect each one separately. Transverse processes are smooth and well covered; firm pressure is required to push your fingers under the ends. Loin muscles are full.
Condition score 4	Spinous processes can just be felt, with firm pressure, as a hard line and are level with the flesh on either side. The ends of the transverse processes cannot be felt. Loin muscles are full.
Condition score 5	Spinous processes cannot be felt at all. Transverse processes can be felt. Loin muscles are very fully developed.

A body score, taken at regular intervals, can help goatkeepers decide upon their management policy. For example, during pregnancy they can identify those goats which are in poor condition and will require extra feeding and care so that good strong kids are produced and the nanny will have sufficient milk to rear them. It can also help goatkeepers decide when they are in the right condition for sale or slaughter.

4 *Catching and restraining a goat*

The easiest way to catch a goat is to bribe it with food! If this fails a group of goats can be herded into a pen or enclosure from where individual animals can be caught. Approaching from the side and catching the

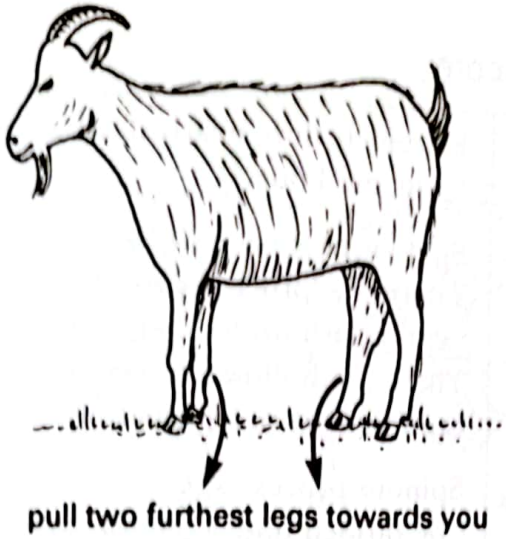


Fig 6.5 *Restraining a goat*

horns, leg or neck usually succeeds. The goat can be manhandled to a sitting position by:

1 first reaching under the belly and gently pulling the two furthest legs towards you.
2 With the goat now on its side lean over to catch both front legs, back up the goat towards you so that it sits on its bottom (Fig 6.5).

An alternative method is to put one hand on the shoulder and one under the neck and carefully twist the goat into the sitting position (Fig 6.6). Mind the horns! Feet can now be examined and hooves trimmed.

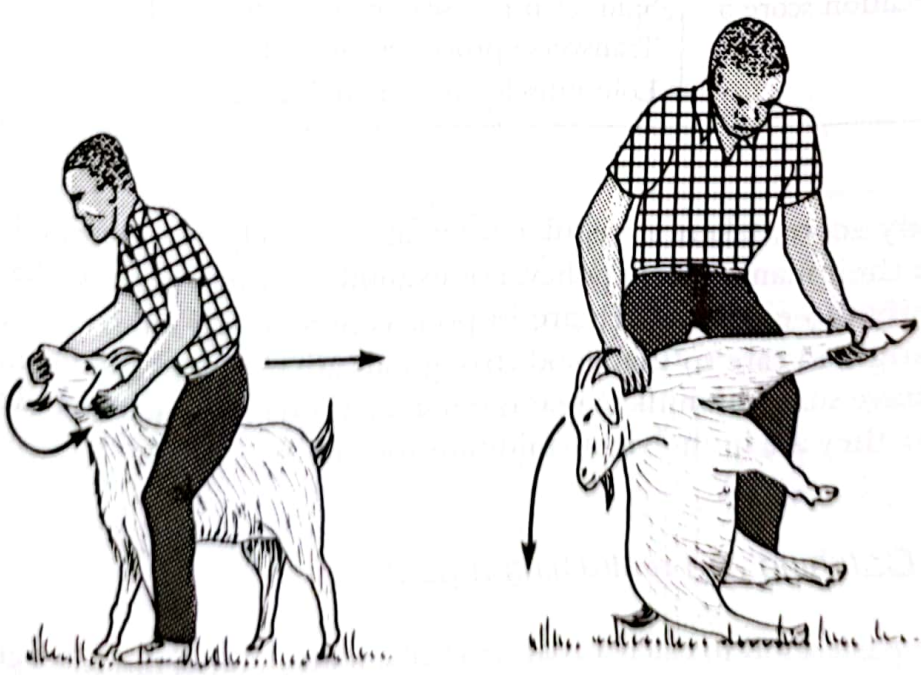


Fig 6.6 *Holding and twisting a goat*

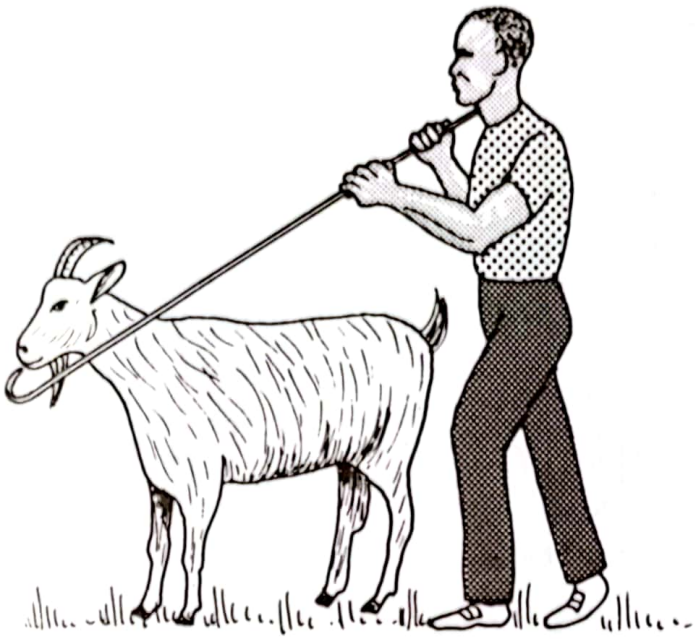


Fig 6.7 *Using a crook*

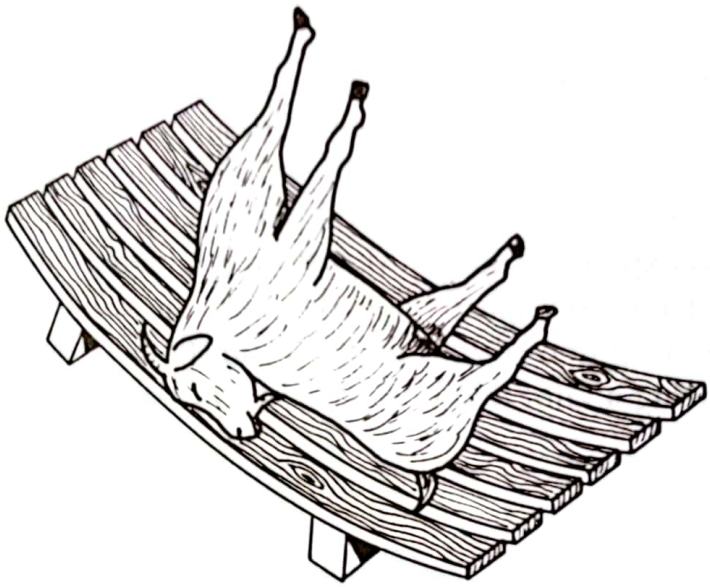


Fig 6.8 *Using a cradle*

It is also possible to work by sitting on the goat when it is on its side on the ground. A helper is always useful to hold the goat.

Crooks (Fig 6.7) can be used to catch both goats and sheep. The hook at the end of the crook is made to catch either the foot or neck. Once the crook is around the goat the catcher uses it to pull the animal towards him or herself.

Cradles can be made or purchased (Fig 6.8). These can be made of wood or sacking. Each goat must be lifted in and out.

If the goat is friendly it can be restrained in a standing position using

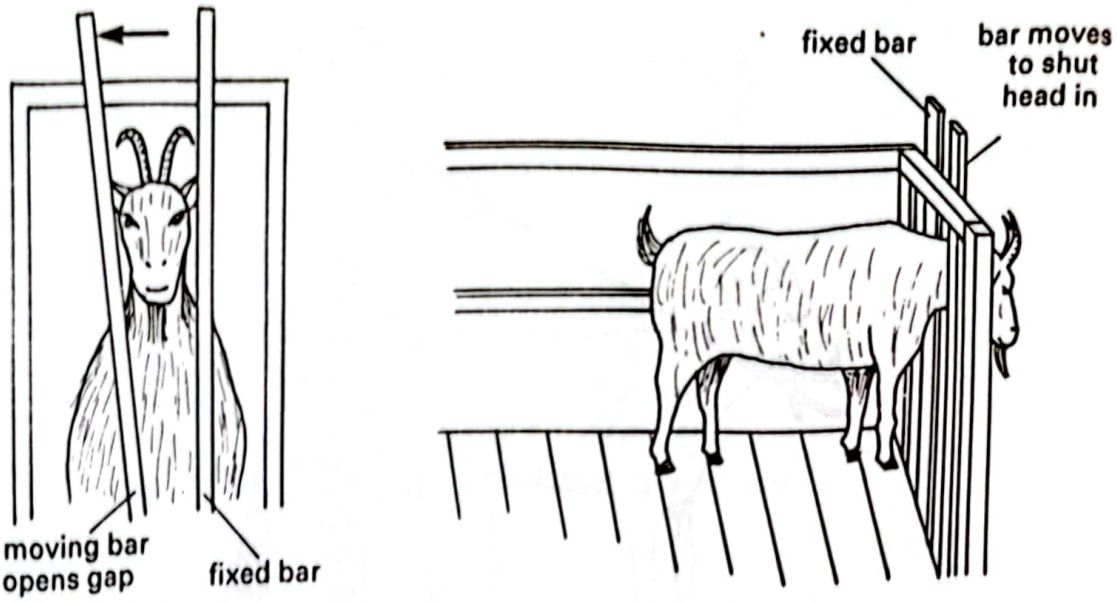


Fig 6.9 *A neck crush*

a neck crush. This is the device shown in Fig 6.9. The neck is trapped between two pieces of strong upright planking. One piece is fixed and the other moves within a frame to allow the head to be put through and then closed to hold it in place. The frame can be driven into the ground or mounted on a wooden platform on which the goat stands. If this platform is raised up above ground level it makes working on the animal easier. A less expensive alternative uses a rope loop fixed to a tree. The loop is just large enough to allow the goat's head through. The rope loop must not tighten so that the goat can strangle itself. This can be avoided by tying a knot that does not slip but holds the loop at a fixed size.

5 *Feet*

Keeping hooves short and in good condition is very important because lame goats will lose condition. Where animals travel across hard or stony ground their hooves tend to wear and require no trimming. Hooves are trimmed with a sharp knife or foot clippers as follows (Fig 6.10):

1 Restrain the goat in either sitting or standing positions.
2 Take one leg and clean the soil and any loose material from under and between the hoof.
3 Clip or slice away the excess nail on the outside of the hoof until it is the same height as the inside. Cut thin slices until confident enough to avoid cutting the soft tissue because this causes bleeding and discomfort to the goat.
4 The heel should also be trimmed to the same height.

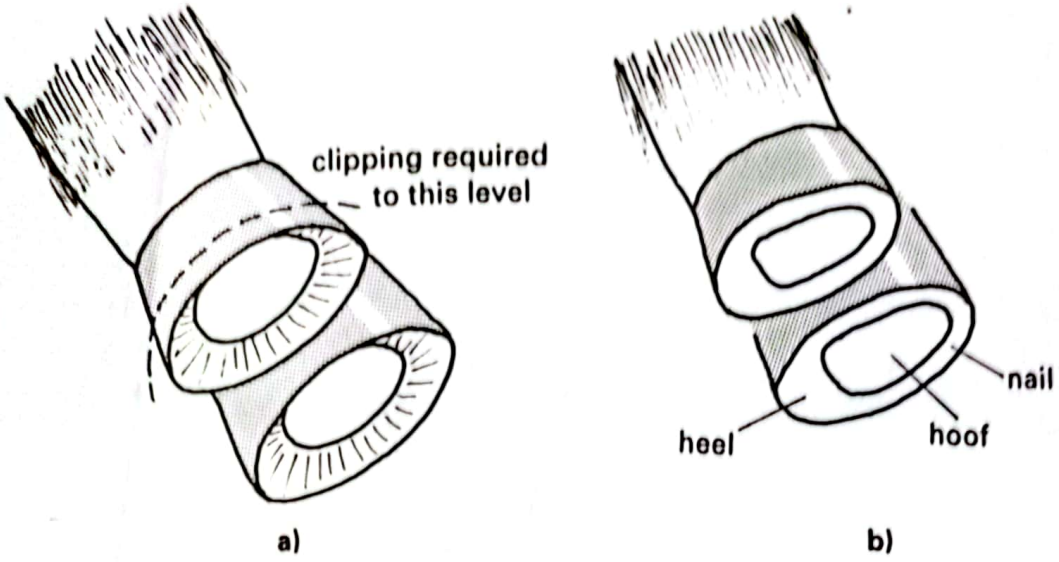


Fig 6.10 *Hoof trimming a) before cutting b) well cut hooves*

5 If the hoof is very long it will not be possible to trim it to an ideal shape at one trimming session. Where the hoof is peeling away at the side, remove any loose material but do not clip up the side to expose the soft tissue.

6 After trimming treat the feet with either
   1) iodine
   2) antibiotic spray
   3) 10 per cent solution of formalin or copper sulphate.

6 *Dipping*

Dipping goats in an insecticide or spraying them with one will kill external parasites and pests and prevent the damage they cause to goats and the diseases they carry. The frequency between dippings depends on the disease risk. Immersing goats is much more effective than spraying them but animals are not keen to jump into a dip bath and will have to be forced. They will try to escape if possible. The construction of the bath must not allow goats to jump out or through the bath without getting thoroughly soaked. Dips that goats wade through may be better than ones where they have to swim.

A simple design for a dip is given in Fig 6.11 and photograph Fig 6.12. It has small pens so that small groups of goats can be handled. Goats are forced towards the dip bath where an operator catches each animal and puts it in the dip. Another assistant pushes the goat's head under as it swims by to ensure that it is totally immersed. He can use a forked stick and thus avoid the chemical getting on his hands. The goat resumes its

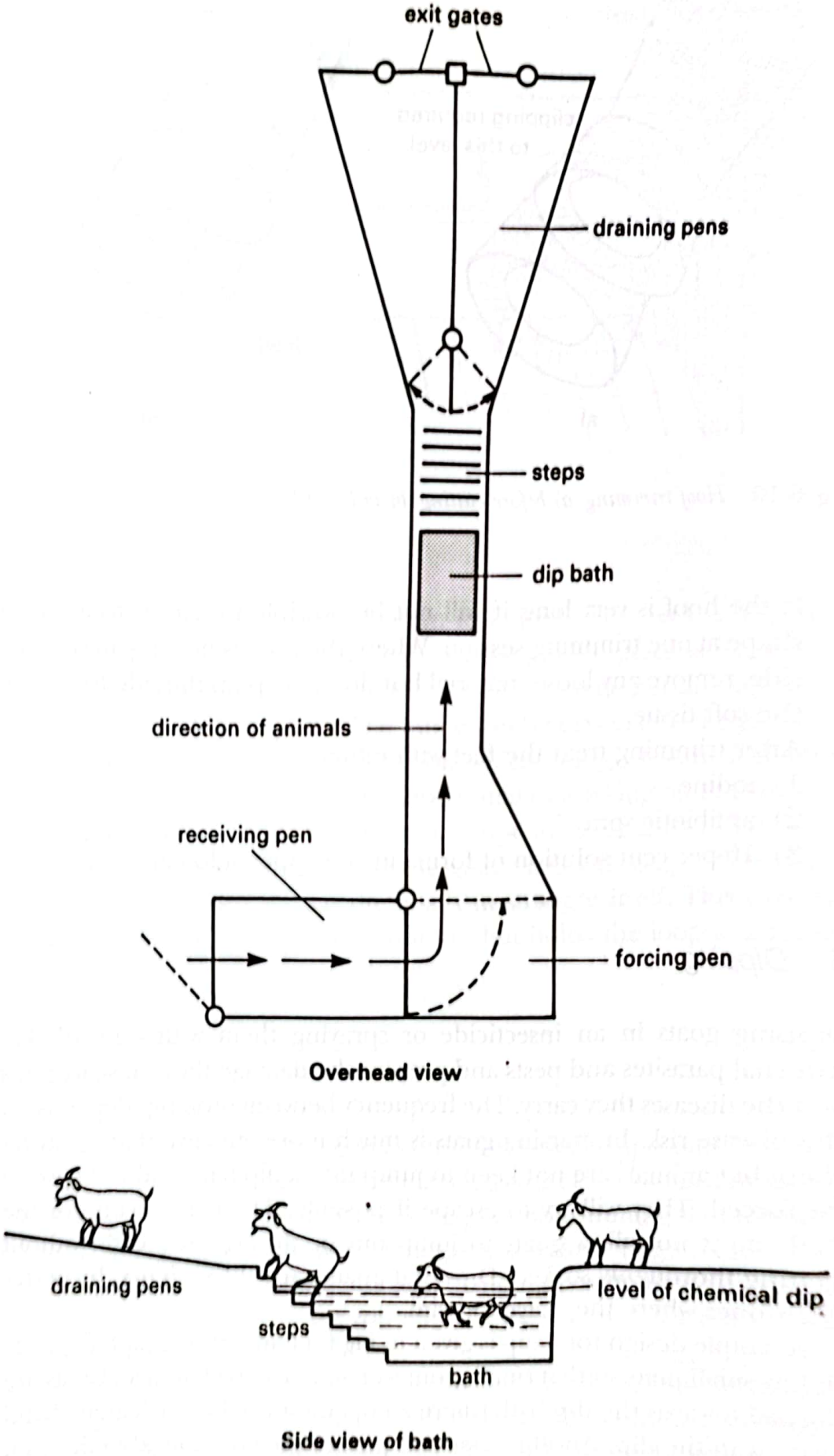


Fig 6.11 *A dip bath*

Fig 6.12 *Dipping some goats*

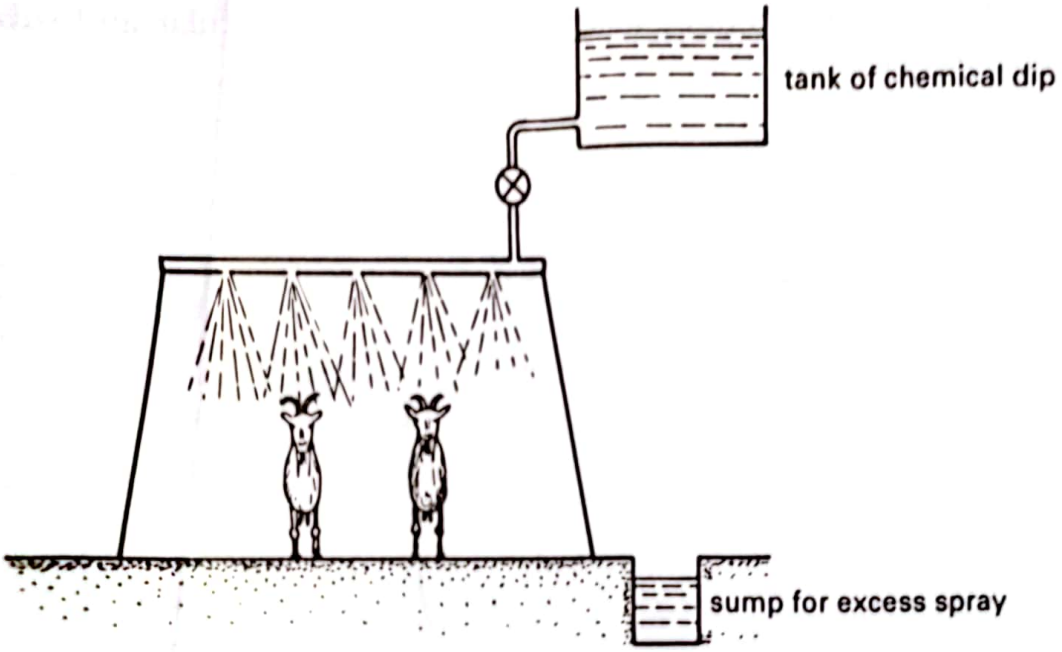


Fig 6.13 *Spray race*

swim to the end of the bath and climbs up the steps to the draining areas which slope back towards the dip. Two draining areas are ideal so that one batch of goats can be dripping whilst another is being dipped. In this way much of the liquid is returned to the bath for re-use. The strength of the insecticide in the bath will be diluted as more goats pass through. Extra chemical dip must thus be added for every 100 animals so that the dip remains strong enough to kill parasites and the dip is deep enough to cover each goat.

A spray race is shown in Fig 6.13. Here the goats are slowly forced through an area where a continuous spray of insecticide is sprayed on to the animals. Ideally goats should be sprayed from below as well as from the side and above to be completely soaked. Excess dip drains to a sump

from where it can be pumped up again for re-use. Sprays require less dip than baths but usually need a source of power for the pump. Also in high temperatures the losses from evaporation of the spray can be high. Spraying may also be less effective in reaching under tails or other parts of the body where ectoparasites might be present.

An alternative is to pen the goats in one place and use a hand-operated backpack sprayer bucket to soak them.

7 *Injecting goats*

7.1 Preparation

As many drugs or vaccines are given to goats by routine injection it is very useful for goatkeepers to be able to give both intramuscular and subcutaneous injections.

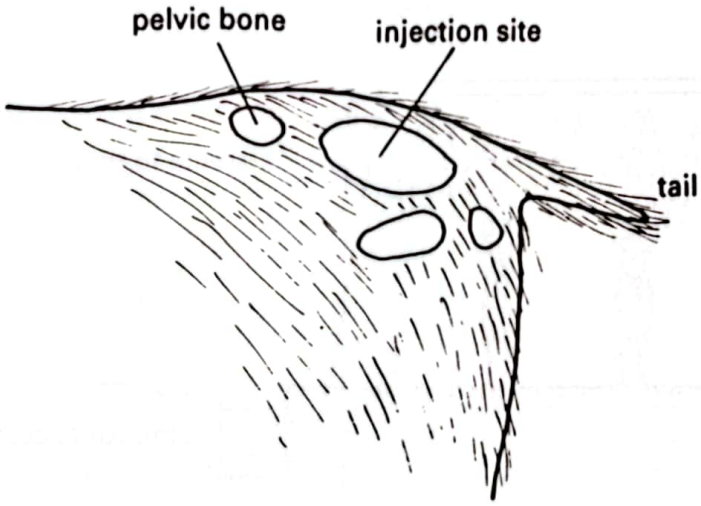


Fig 6.14 *Intramuscular injection site*

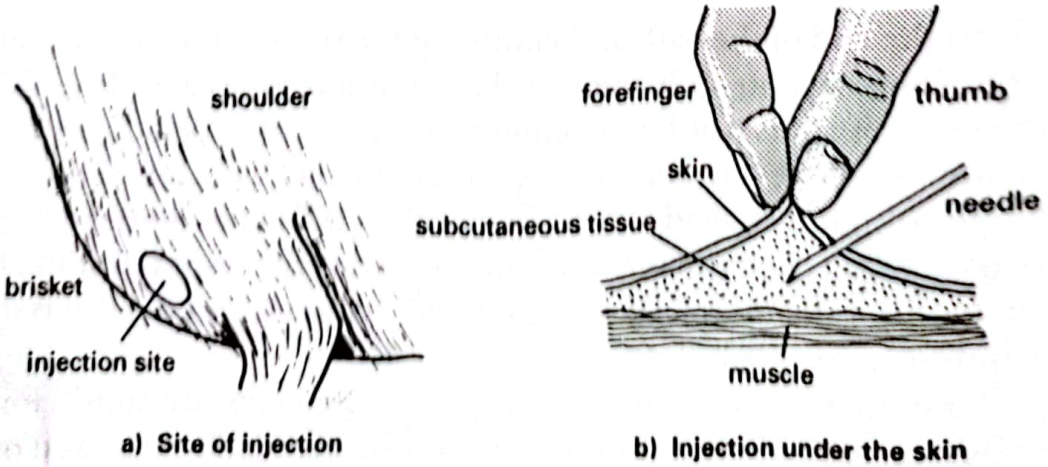


Fig 6.15 *Subcutaneous injection*

Re-useable needles and syringes must be sterilized before use. This is done by boiling them in water for 20 minutes. Equipment, once cleaned, can be stored in methylated spirits. Sterilized automatic injection guns can be stored in plastic bags with clean cooking oil in the syringe barrel. Disposable equipment is an alternative but is expensive. Needles must always be sharp and free of burrs. They can easily be sharpened on a sharpening stone.

To fill the syringe, firstly clean the medicine bottle top and then suck some air into the chamber of the syringe. Then push the needle into the rubber stopper and inject the air inside the bottle. Withdraw the required amount of medicine, hold the needle upwards and slowly eject any surplus air from the syringe.

It is helpful to have an assistant to hold the goat when giving injections although with practice one man can manage.

7.2 Intramuscular injection

1 Restrain the goat by holding it between yourself and a wall with its rear in the corner. Hold the goat's neck with one hand with a knee against the goat's side, just in front of the back leg.
2 The injection area is the muscle behind the pelvic bone (see Fig 6.14) to the side of the tail bone.
3 The area must be cleaned with methylated spirit before injecting if the treatment is not an antibiotic.
4 Holding the syringe where the needle sits on its base, push it carefully 15–20mm into the muscle. Be careful not to hit the pelvic bone.
5 Inject the medicine into the muscle firmly and without excess delay.
6 Remove the needle and rub the area to help disperse the medicine.

7.3 Subcutaneous injection

1 Restrain the goat by standing astride it or having it in the sitting position.
2 The injection sites are in the brisket or 75cm behind and below the ear.
3 Clean the site.
4 With the syringe loaded, pinch the skin with forefinger and thumb, lift the skin and firmly push the needle, slightly angled, through the skin (See Fig 6.15). Care must be taken not to push the needle right through the second layer of skin.
5 Inject the drug.

After all injections are complete the equipment must be stored carefully. Drugs must be stored according to instructions. Even inside a fridge in

the tropics the temperature can be above the minimum required for the long-term storage of drugs. During injection operations spare bottles of vaccines or drugs that require to be kept cool must be stored in a cool box. These can be made out of small wooden boxes lined with polystyrene. Alternatively commercial cool boxes can be purchased.

8 *Castration*

Because bucks can be sexually mature at around three months of age castration may be necessary before this age to avoid uncontrolled matings.

Castration involves either the removal of the testes or crushing the blood vessels to the testes which causes them to wither. Three methods are available.

8.1 The burdizzo (the bloodless castrator) (Fig 6.16a)

This is a pair of commercially available pincers that are used to crush vessels that convey blood to the testes. The procedure is commonly used on older goats.

1 Treating one testicle at a time, force the testicle down into the scrotum so that it is well clear of the goat's body.
2 Clamp the burdizzo on the scrotum above the testicle to crush the cords. Each cord should be clamped in two places, the highest first.
3 The crushed skin should be covered in antiseptic to discourage fly strike.

8.2 Rubber rings (elastrator)

Using rubber rings (elastrator) (Fig 6.16b) is an alternative method that is suitable for very young kids. A special pair of pliers are used and it is easier performed with the help of an assistant.

1 The assistant catches the kid and holds it up by its front legs facing the operator.
2 The testes are drawn down in the scrotum clear of the body.
3 A ring is placed on the elastrator, which is opened and placed over the scrotum so that the ring can be put above the testes and below the body. Care must be taken not to catch the male teats in the ring. Tying this area with string or bamboo is used under traditional systems but can lead to open wounds, tetanus or fly strike.

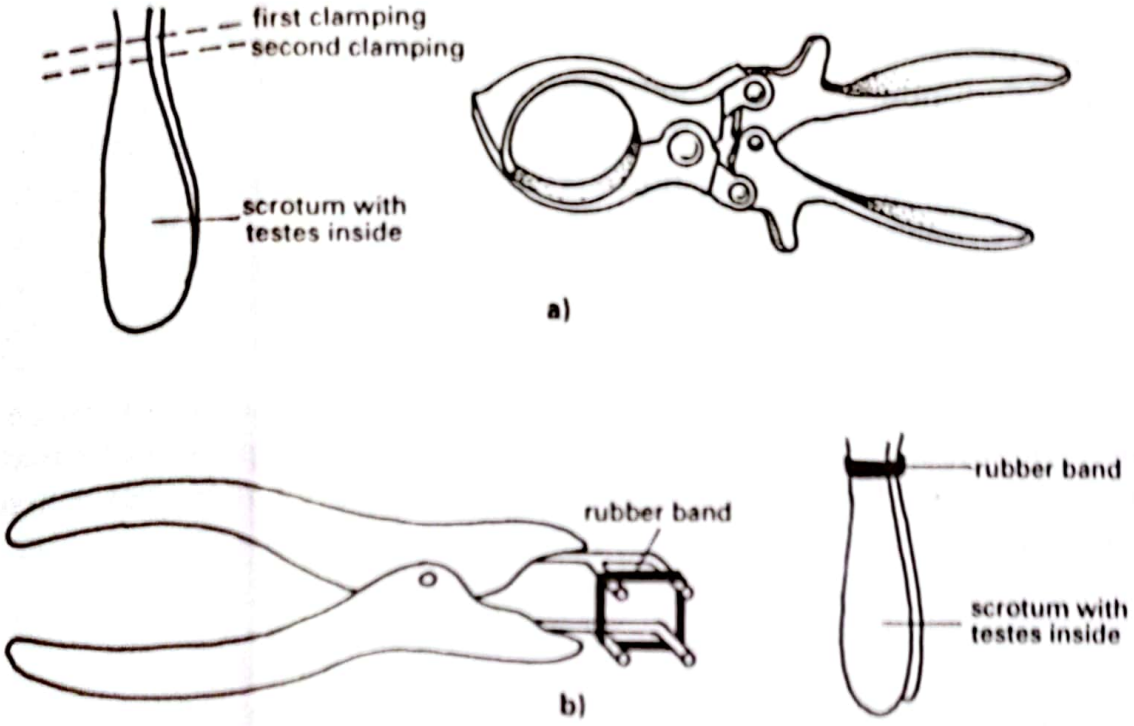


Fig 6.16 *a) Burdizzo b) Elastrator*

8.3 Surgical removal of the testes

This is a traditional way of castrating and is still satisfactory if good hygiene is observed. It is best used for goats between 1–3 months. All equipment should be sterilized and the following procedure taken.

1 A helper holds the kid on a flat clean surface with its scrotum exposed.
2 The scrotum and surrounding area is cleaned with disinfectant or alcohol.
3 The lower end of the scrotum is slit open.
4 The testes are gently pulled out from the scrotum and cut off by cutting through the sperm cord and blood vessels above the testes.
5 The whole scrotum is dipped in antiseptic powder or iodine. The area must be inspected daily, for a week, to prevent infection and fly strike.

For the good welfare of the animal, a local anaesthetic should be used when castrating. This is not necessary when rubber rings are used on kids in the first week of life.

9 *Culling*

Culling is the process of selecting out from a flock those goats which are no longer worth keeping. The principal reasons for this include:

- goats with poor teeth that cannot feed properly
- goats with poor udders, which cannot rear kids satisfactorily
- diseased or injured goats
- goats with poor fertility or non-breeders
- excess animals (e.g. too many males)
- old age
- animals with breeding faults.

Animals should be culled for the above reasons when it suits management or when a good market is found for them. Surplus adults may therefore be sold at the end of the rearing period or at festivals when prices are high.

10 *Record keeping*

Keeping basic information about the flock can be a very useful management tool. Any records should be simple and perhaps include:

- Nanny's date of birth and pedigree (names of parents)
- Kid's date of birth, sex, weight and notes on any birth problems
- Individual or flock health problems.

These records could be kept in a daily diary. All such data would help plan any breeding programme and identify unproductive animals which need treatment or culling.

Where animals can be weighed, records will identify which goats grow fastest and might become good breeding stock. Recording dams' milk yields can help identify good mothers. Farmers can also keep financial records including sale prices of animals, milk and fibre and the cost of animals, feeds and medicines.

11 *Identification*

On small farms goatkeepers will often know all their stock by sight. This is more difficult with larger flocks or where flocks graze together. All the goats in the same flock can be marked in the same way so that they can be identified as belonging to one person. This may help recover them if they are lost or stolen. It may also be useful to mark animals individually, and where records are kept this will aid management. Three methods of marking (tattooing, eartagging and earmarking) are outlined below.

11.1 Tattooing

Animals can be tattooed on any part of their skin that can be seen but the ear is the most popular place. Marking ears avoids damaging the skin which may be used in leather production. The process involves making a series of pierced marks through the ear and rubbing in Indian ink. The equipment required is:

- lettering
- Indian ink
- methylated spirits
- tattooing pliers
- records.

The process is as follows:

1 Place the letters or figures in the tattooing pliers and test on paper.
2 An assistant holds the goat in the standing position, legs astride the goat and hand on the neck. Older goats will try to rear up whilst younger ones will try to run forward.
3 Clean the ear of wax and dirt with methylated spirits.
4 Smear ink on the inside of the ear.
5 Line up pliers between ear blood vessels in middle of ear.
6 Squeeze pliers with quick firm movement to penetrate skin (assistant restraining goat!).
7 Remove pliers and rub more ink into holes using a stiff brush.

The skin takes one to three weeks to heal. Old tattoos can be read by shining a torch through the ear. To read any tattoo it is necessary to catch the animal.

11.2 Eartagging

Putting a tag in a goat's ear enables it to be identified throughout its life (Fig 6.17). This can be very useful for management of breeding. For example, nannies producing large litters can be identified and retained or animals that consistently prolapse can be sold.

Eartagging may have little advantage to the smallholder who, with small numbers of goats, knows the history of each of his animals. Tagging may actually create problems because tags may become snagged and ears torn which can leave open wounds that can become infected.

Tags can be neat and small so that they do not get caught or larger so that big numbers can be written and then read from a distance.

The procedure for tagging

1 Dip the tags and applicator in disinfectant.
2 Write the number on the tag before tagging.

Fig 6.17 *An eartagged goat*

3 Restrain the goat in the standing position.
4 Clean ear with methylated spirits.
5 Clip tag into ear with applicator, avoiding ear veins. The tag is best placed as near to the head as possible to reduce the chances of ripping. The number should be on the outside. Placing tags in different ears to denote the animal's sex can help sort animals in large flocks.

11.3 Earmarking

This involves cutting notches out of the side of the ear in a sequence such as that shown in Fig 6.18. The diagram shows a system where the position of a notch indicates a number. This goat has tens on its left ear and units on its right. The cut at the top of the ear denotes 1, the side 5, the bottom 3. This goat is number 92.

The cuts can be made with a sharp knife or an ear clipper. The operator should try out his system on a piece of paper or leaf. Ears should be cleaned with antiseptic before clipping and the goat restrained.

11.4 Fire and freeze branding

Traditionally goats have been branded with a hot iron without anaesthetic. This is painful and cruel to the animal and should be discouraged. Branding can reduce skin values. Freeze branding is practised in

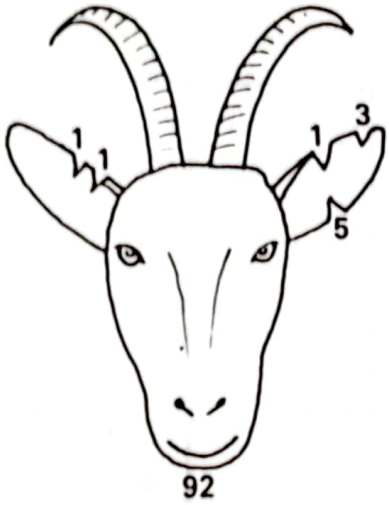


Fig 6.18 *A goat with clipped ears*

temperate areas. Marking the horn or face will enable the goatkeeper readily to identify his animals. Horns can also be painted different colours.

12 *Farm layouts and pens*

For the routine handling and management of larger numbers of goats, handling pens are very important. Such handling and management includes catching, dipping, spraying, foot treatment, injecting, weighing and clipping. Much time can be saved if any pens are carefully planned and well constructed.

Handling pens should ideally be sited centrally on the farm close to water, shade and electricity if available, and be accessible to vehicles if goats are transported by road. Pen floors can be of beaten earth, sand, stones or gravel and should be raised a little above the surrounding ground if drainage is good. Trees or simple roofing made of local materials (e.g. matting) will provide shade that enables both farmers and animals to remain cool. Pen sides can be made of wire, wood, brush or even stones, but must be escape proof.

An ideal layout could include a receiving pen. forcing pen, crush, race, sorting gate, footbath, dip or spray race, draining pens and a holding pen (Fig 6.19).

The *receiving pen* should have a wide access and be able to take all of the goats on the farm. This leads into a *forcing pen* which is either circular or rectangular but smaller than the receiving pen. If assistants are scarce the forcing pens will need gates which when closed force the goats into the *race* or *dip*. The *race* is a long narrow passage wide enough for only one goat at a time. It should be wider at the top than the bottom (Fig

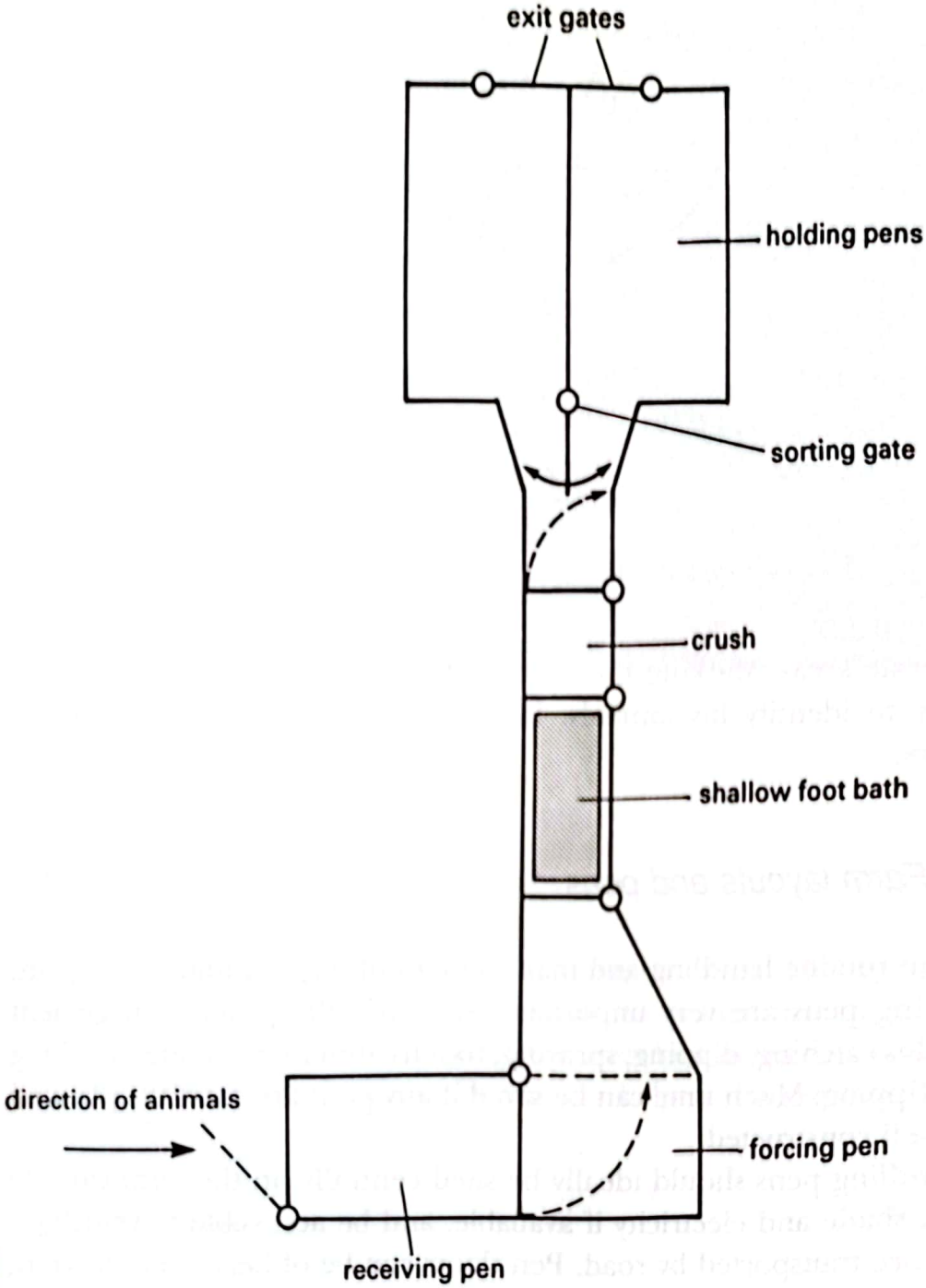


Fig 6.19 *Handling pens*

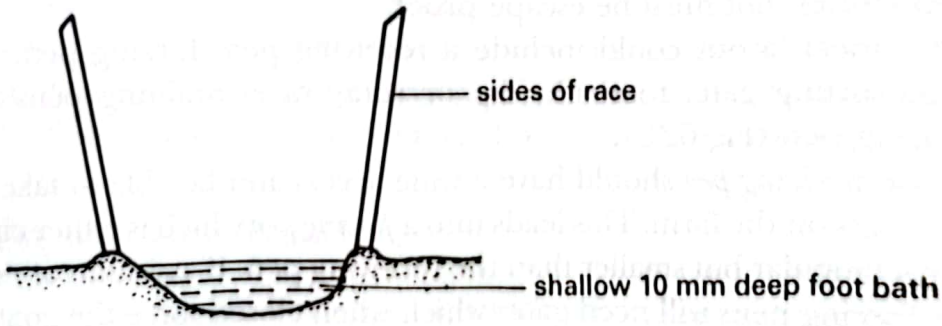


Fig 6.20 *Race with a foot bath*

6.20) and with solid tall sides made, for example, of corrugated sheeting, so that goats cannot escape either through or over the top. A shallow *foot bath* can be constructed in the bottom of the race so that goats' feet can be treated by running them through a formalin solution.

A *sorting gate* can be sited at the end of the race so that goats can be diverted to different pens as they run through. This is a very speedy way of separating different types of animals (e.g. nannies and kids). The *crush* is the same shape as the race except that it has a gate at each end so that one or two goats can be restrained for examination and treatment. The people treating the goats stand either in the crush or lean over from outside.

Dips (see page 87) are normally rectangular but are occasionally circular baths in which goats can be totally submerged in liquids that kill parasites (Fig 6.12). An alternative to a dip bath is a *spray race* (Fig 6.13).

If goats are to be clipped or combed for their fibre, a clean area is needed. Ideally this should provide shade for both the people clipping and for the goats, and should be light and well ventilated. Fibre should be collected after each goat rather than at the end of the day and put in a clean dry place. The floor must be kept clear of dung and urine. The presence of pens nearby in which a group of goats can be held makes catching each goat quicker and so time to clip all the goats shorter.

12.1 Shelter

Goats like shelter and will make good use of natural features such as trees and shrubs. Areas containing such features, if not over used, can provide healthy environments. The type and amount of shelter needed is affected by the weather, climate, predators and management system. Goats do not like getting wet and if they do it can lead to pneumonia and increased parasitic infections. High temperatures can also lead to health problems from heat stress and excess losses of water, sodium and potassium.

12.2 Housing

The type of housing required will reflect the complexity of the management system. Low-cost extensive systems will have rudimentary housing such as night shelters for flocks that are grazed in the day but returned to the village at night. This system would provide protection against the weather and predators.

All housing needs to be well ventilated, light, well drained and easily cleaned. The following points are important in providing housing:

1 A well drained site should be selected.

2 The floor, which is commonly of rammed earth, must be kept dry and drain well. Bedding can be made up of dried straw or wood shavings.

A raised floor made of wooden slats is an alternative (Fig 6.21). These slats should be narrow enough to avoid younger goats getting their feet trapped. Concrete is a good but expensive type of floor.

3 Using locally available materials is preferable. Roofing should be waterproof. Galvanised roofing sheets enable water to be collected in dry climates but may create very hot conditions beneath them at high ambient temperatures. Because goats will chew structures, any timber used should be free of toxic substances and paints should be lead free. Sharp edges, exposed nails and places on which goats might catch feet or horns should also be avoided.

4 Housing must be cleaned regularly to avoid a build-up of dung, and associated infections and parasites.

Size of houses and layouts

As overcrowding leads to bullying and poor health, housing areas must be large enough to take all animals comfortably. A rough guide to floor space is given in Table 6.2.

Table 6.2 Floor space requirements for goats

Types	Space needed per animal (square metres)
Kid	0.3
Non-pregnant nanny	1.5
Pregnant nanny	1.9
Buck	2.8

Thus the floor space needed for a herd of two males, 10 pregnant females and 12 kids is worked out as follows:

2 males	2 × 2.8 =	5.6
10 females*	10 × 1.9 =	19.0
12 kids	12 × 0.3 =	3.6
		28.2

28.2 sq. metres is provided by a 5m × 6m house.
*using the size for pregnant females.

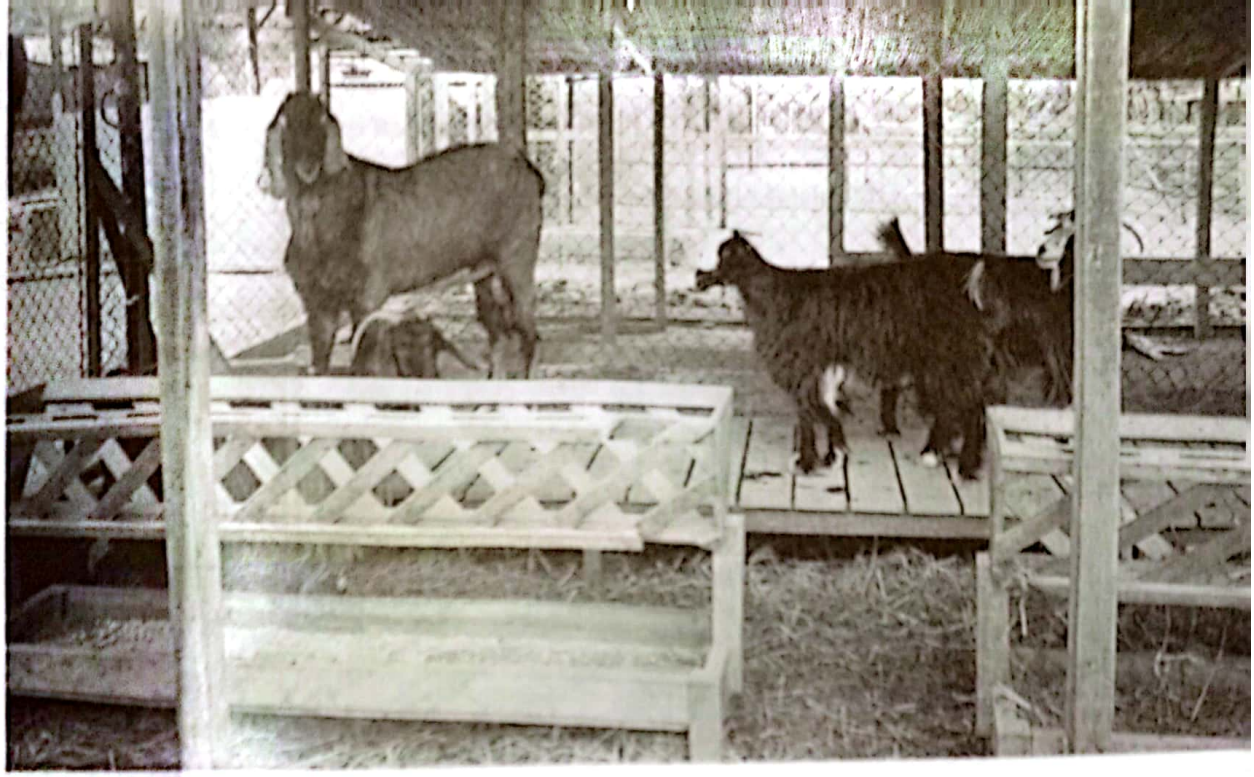


Fig 6.21 *Raised floor in goat shelter*

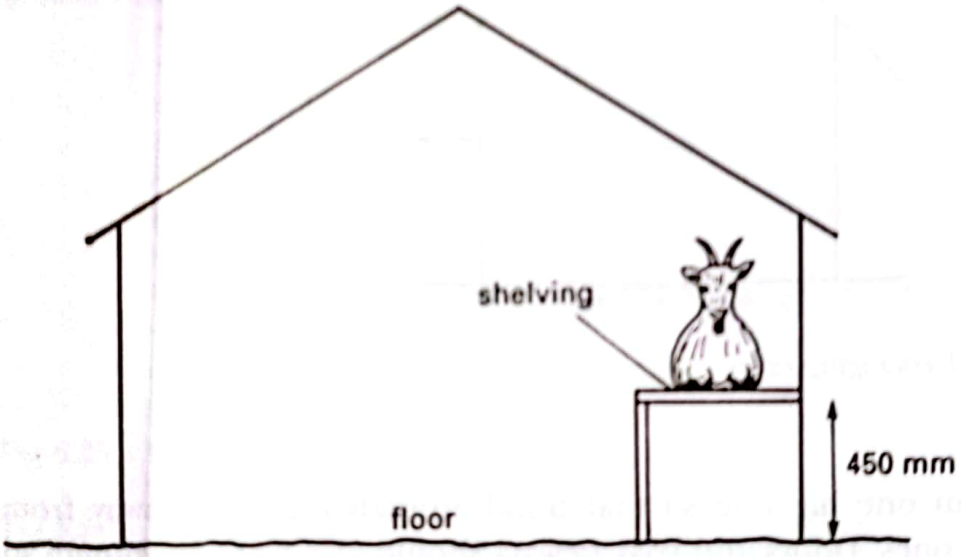


Fig 6.22 *Cross-section of shelving*

A useful feature that avoids overcrowding is to provide shelves where the younger kids can sit. These are sited against the walls for kids to sit comfortably (Fig 6.22).

Within a flock there is a distinct order of dominance between individuals called the *pecking order*. The strongest male or older females are usually paramount. These goats may well force the more timid or younger animals out of houses or away from feeding areas. Bullying may also occur which can cause stress and make goats more susceptible to diseases. It is therefore a good policy to have a number of smaller houses

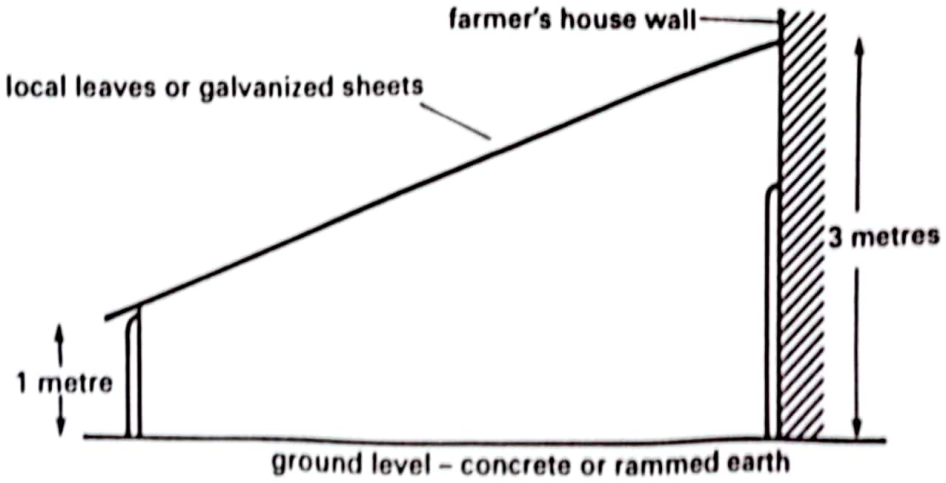


Fig 6.23 *A lean-to house*

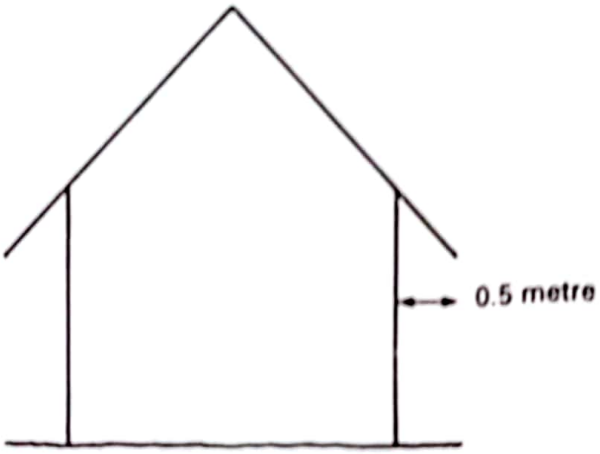


Fig 6.24 *Overhanging eaves*

rather than one big one so that timid animals can move away from dominant ones. Doors and passageways should also be wide enough so that no one animal can block the movement of others.

If animals have horns extra space is required inside the house. Roof spaces within the house must allow adequate ventilation but need not be excessively high. Where the weather dictates the need for shelter during the day, a flock should have access to housing if no natural shelter is available.

Types of housing

In climates where the rainfall is not high many goat houses are built at ground level. In many parts of Africa, W. Asia and the Middle East *lean-to* constructions are popular. They can be built attached to the farmer's home (Fig. 6.23).

In the wet tropics houses with *sloping eaves* are very practical. Long overhanging eaves (Fig 6.24) stop the rain being blown into the house. As goats are very susceptible to pneumonia, damp and poorly-ventilated housing can lead to a much higher incidence of the disease.

Houses with *raised floors* (Fig 6.25) or on *stilts* (Fig 6.26) have a number of advantages. Ventilation is good and the dung and urine drops through the slatted floor so it does not build up and cause disease problems. The

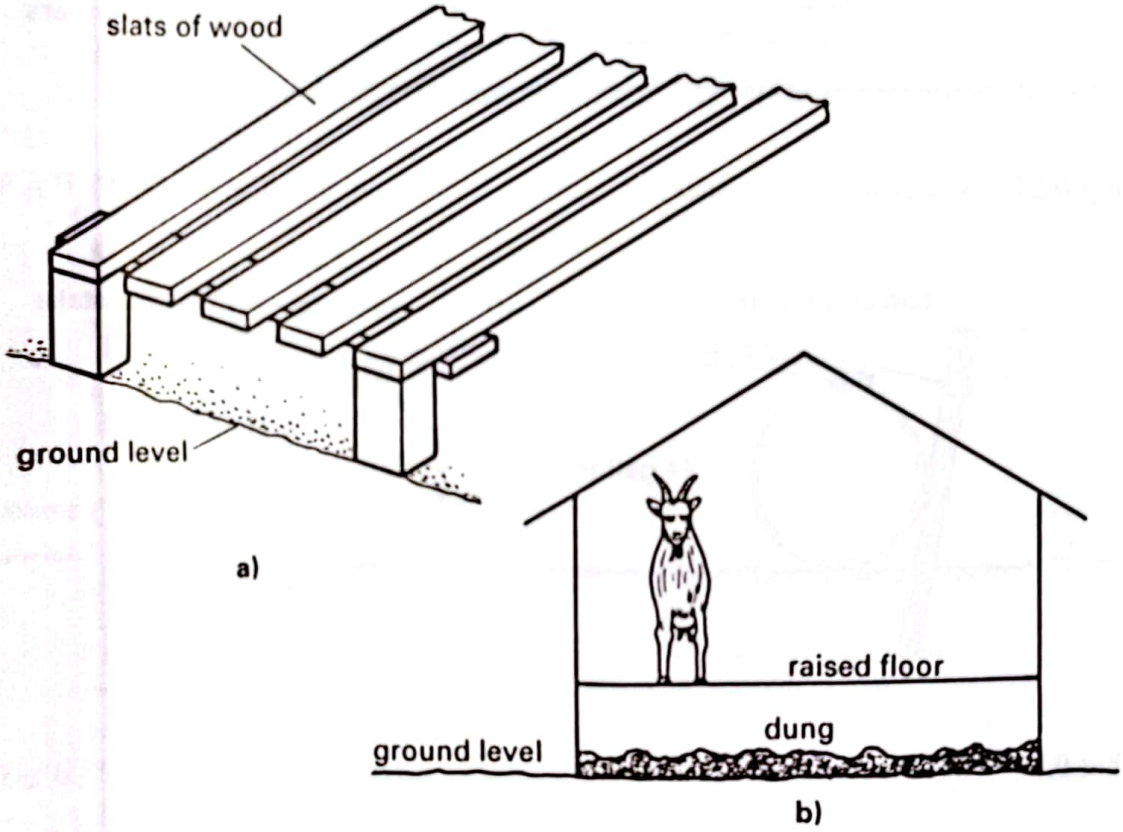


Fig 6.25 *A slatted raised floor*

Fig 6.26 *A house on stilts*

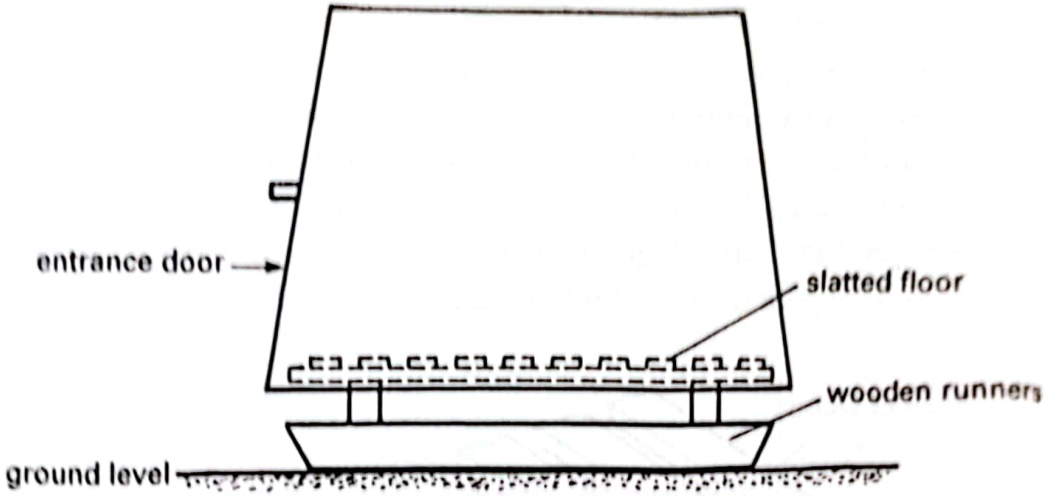


Fig 6.27 *Side view of a moveable ark*

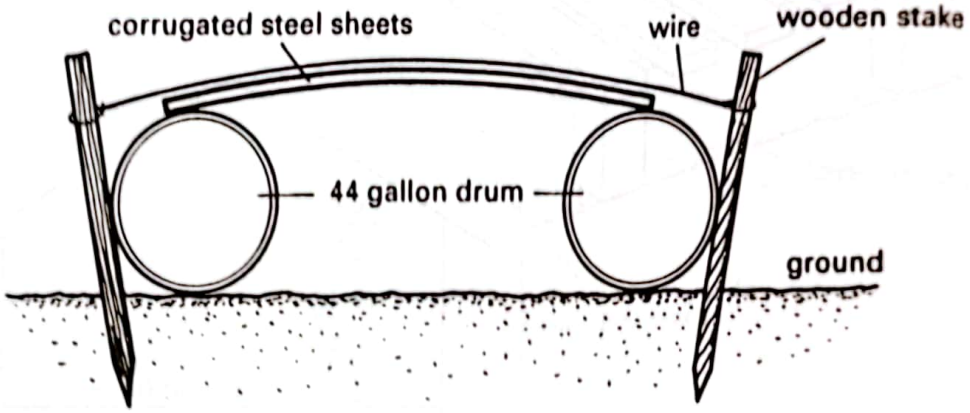


Fig 6.28 *Side view of a simple house*

dung can be collected from under the house for use on crops or in fish ponds.

Where tractor or draught power is available goats can be housed in moveable buildings called *arks*. The arks are pulled around the grazing area when the dung under the ark has built up. This reduces health problems and can spread manure around the pasture. Such arks must be strong enough to be pulled and usually have strong wooden runners beneath them to enable them to slide along. These houses either have slatted floors or just use the ground as a floor (Fig 6.27). Some simple houses can be dismantled, moved and rebuilt (Fig 6.28).

13 *Food and water supplies*

The provision of adequate feeding space and water points is extremely important to the long-term well-being of the flock when goats are con-

Fig 6.29 *A water trough for goats in Oman*

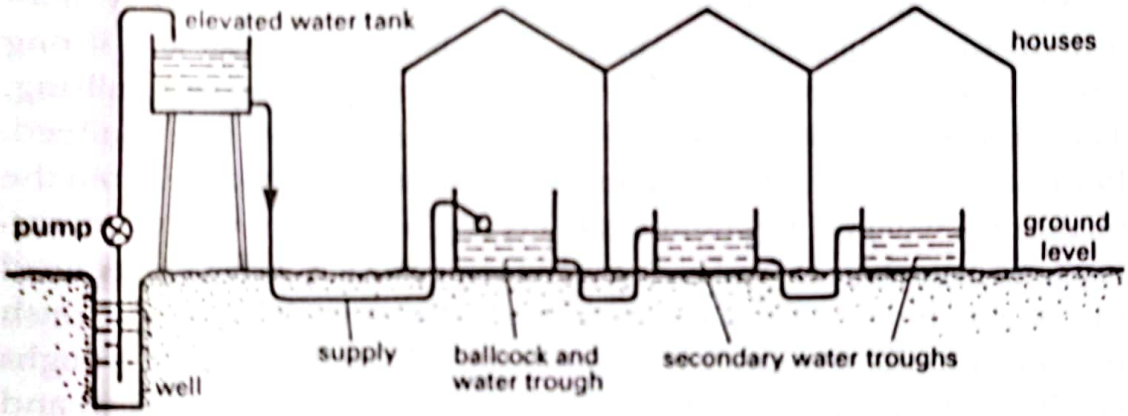


Fig 6.30 *A water supply system*

fined. For small flocks watertight tins, buckets or bowls can be adequate for watering and feeding. They should be placed so that goats cannot stand in them or knock them over. Small kids should be able to drink out of them without falling in. All bowls must be kept clean of waste and rubbish or vegetative growth. Fresh water should be put in daily (Fig 6.29). For larger flocks using natural water sources will save much labour. A good goatkeeper will ensure that his flock has access to water during its grazing period. If goats are eating moist or succulent forage, then once-a-day watering may be adequate. Where animals are housed for any length of time permanent, more sophisticated, watering systems are needed. Fig 6.30 shows a simple example where one tank controlled by a ballcock automatically provides a supply to a series of troughs.

Mould and algae as well as mosquitoes and snails will all grow in water systems and can lead to contamination and disease problems. Regular emptying and cleaning of pipes, tanks and troughs will eliminate most

difficulties. Repairing leaks that can cause large damp areas in houses and encourage pests and diseases is also good practice.

The number of drinking points required depends on the number of animals and the size of water troughs. If access is not restricted then fewer water points are required. Each animal should have approximately 30 to 40cm of space allocated at the trough.

13.1 Feeding troughs

Where animals are fed either on concentrates or forage, racks or troughs are required so that all the animals can feed at once. Body width will, therefore, determine how many animals can feed from one trough but approximately 30 to 40cm is the likely minimum. Horned animals will require a wider space.

Round troughs will be able to accommodate many more goats than troughs with straight sides. Troughs must be easy to clean and strong enough to withstand the effects caused by goats pushing and bullying. They should be built with a height so that animals of all ages can feed. Because goats can climb and jump into racks and troughs and so foul the feedstuff, a system of tombstone barriers (Fig 6.31) is one way of preventing expensive losses. Under this arrangement each goat puts its head through an individual wooden barrier to eat without being able to push its body into the trough. If built on to the side of the pen, the troughs can be easily filled without the goatkeeper having to enter the pen and being mobbed by the goats.

Where bulky foods such as grass or browse are given, racks made of metal, wood or netting enable goats to eat on demand (Fig 6.32). Because goats will tend to pull forage through the rack and waste it on

Fig 6.31 *Tombstone feeding barriers*

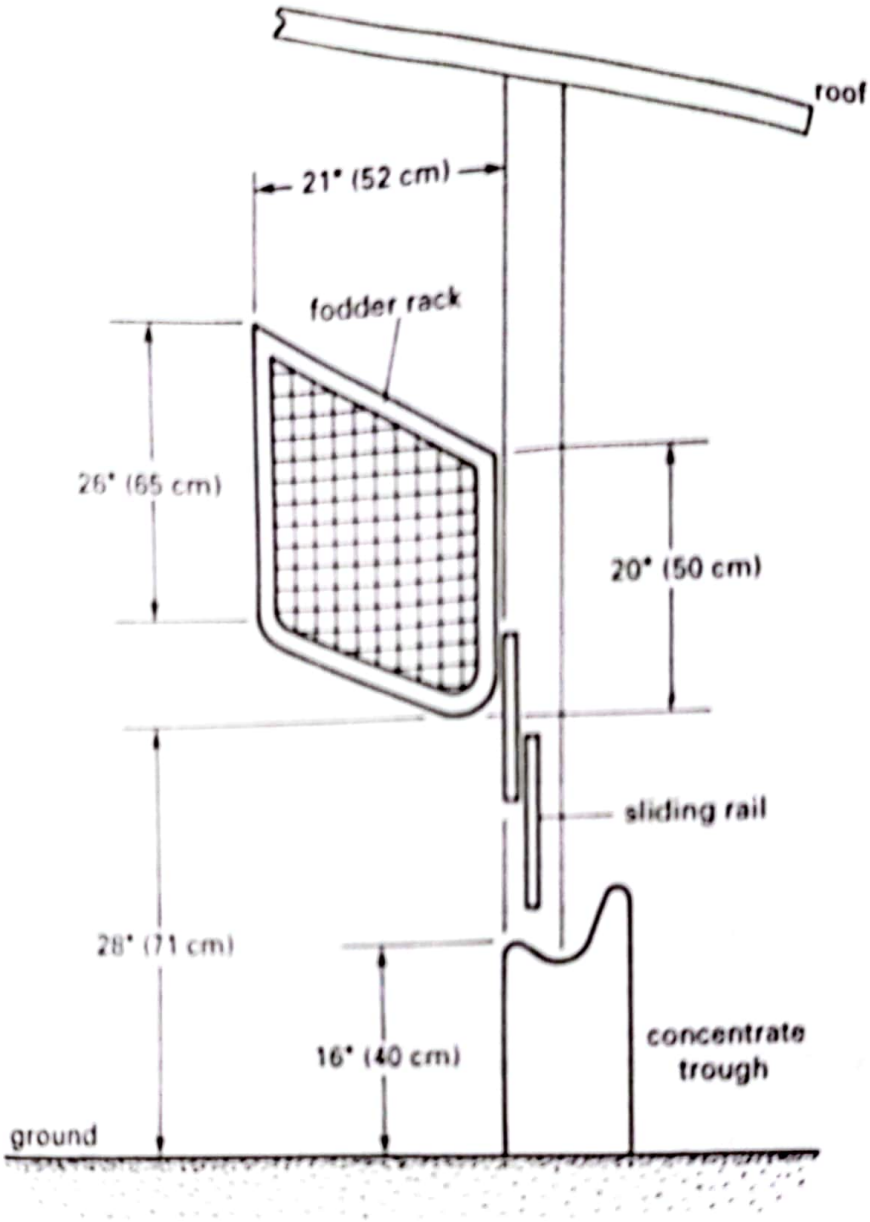


Fig 6.32 *A fodder rack*

the floor, the size of the mesh is important. It must be small enough to allow the goat to eat without being able to pull large quantities of material through. Ideally, the rack should have a lid or sides high enough to prevent goats jumping in. If built on the side of a house or pen, they should be mounted at head height for the goat, with the goats' side taller than the side where the goatkeeper places the forage.

14 *Fences*

Goats are not easy animals to enclose. High concrete walls, wire net fences (Figs 6.33 and 34a) and electric fencing (Fig 6.34b) can be very

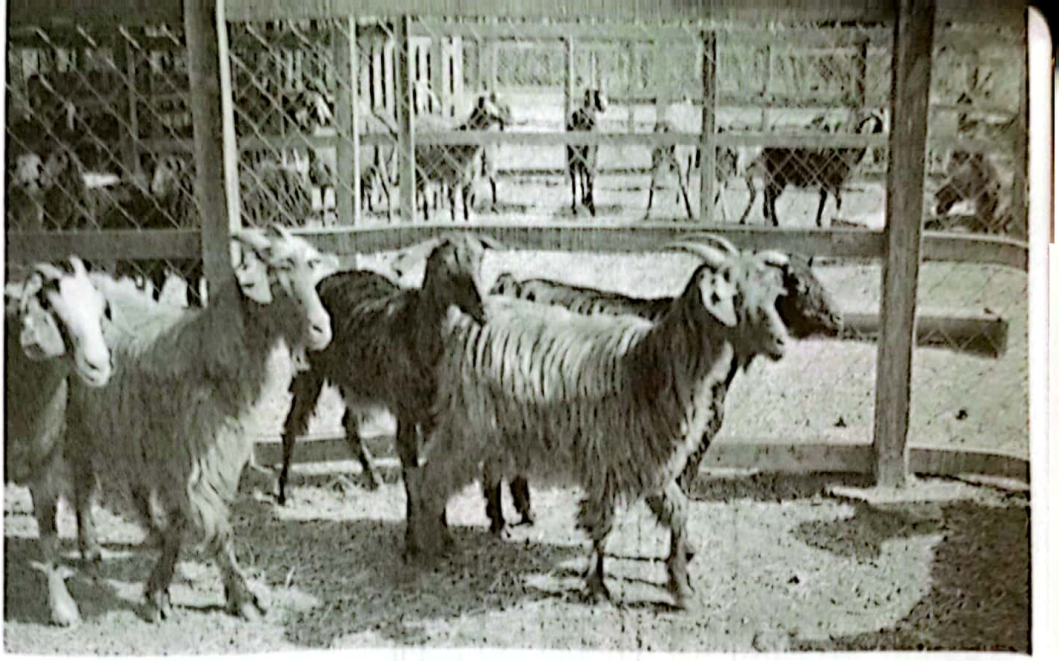
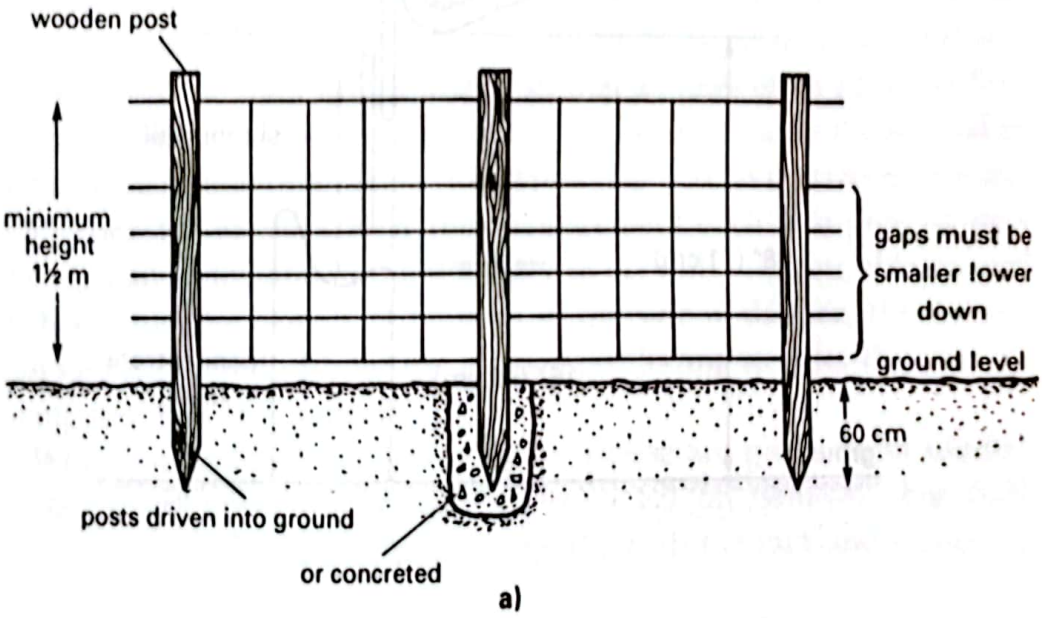


Fig 6.33 *Wire fencing*



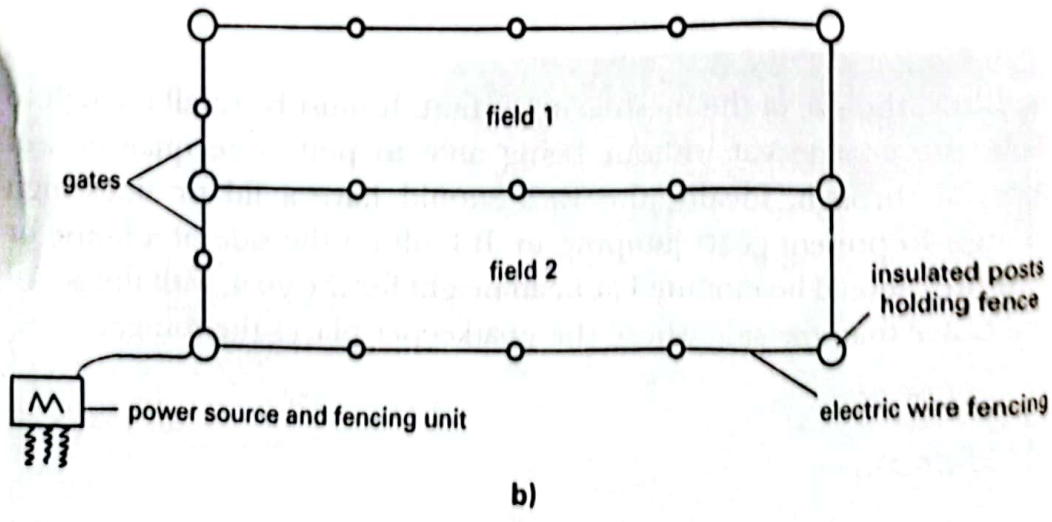


Fig 6.34 *Fencing a) wire fences (side view) b) electric fences (plan)*

successful but are expensive. Wire net fences may cause problems because young goats may get their legs or horns caught in the mesh and the fences may be damaged by goats climbing up them. Goats may also fight between pens or use the fences to scratch. This action stretches and breaks the wire. Goats will also chew electric fences if they are made of plastic.

As goats are excellent jumpers fence heights must be a minimum of one and a half metres high. If fences are made of timber rails, the maximum gap between should be about 15cm. If wire is nailed on to these rails the timber should be outside the pen so that goats do not use the wood as ledges to jump out.

Gates that swing are easier to use than hurdles that must be lifted, but goats will learn to open bolts and latches if within reach. The position of a gate in a pen must assist the movement of the goats – for example, a gate in a corner is easier to herd a group through than if it is in the middle of a pen.

Electric fencing can be very successful if goats are trained to respect the fence. A single electric wire strung as an outrigger 25cm above the ground will keep goats away from a conventional electrified sheep netting fence. If some goats are persistent escapees, they should be culled or sold or separated from the main flock because they will always encourage other goats to follow which will lead to any system breaking down.

14.1 Confining bucks

Extra measures are usually needed to restrain entire males to avoid unplanned mating. The following points should be considered:

1 Bucks should be kept out of sight of nannies except at mating time.
2 Bucks should be penned or tethered separately from the main breeding flock.
3 Young nannies can breed from three months of age and must be separated from male adults and male kids before this age. Nannies are best bred after they reach 70 per cent of mature adult weight.
4 Continual human contact improves the behaviour of unruly males.
5 Males can be grouped together as they soon establish a pecking order that enables them to live in harmony. Introducing new animals into this group must be carried out carefully to avoid bullying. Putting animals in adjoining pens in the first instance will enable them to get used to the sight and smell of each other. Putting them in small pens will also reduce fighting and so damage to each other.
6 Entire males usually smell! The chemicals involved can taint the milk which may make it more difficult to sell.

7 Growth and meat

1 *Growth*

As goats grow, their body composition changes. The rate of growth of a goat depends mainly on the amount and quality of food available and the health of the animal but is also influenced by its genetic make-up and its sex. In most tropical situations goats receive a diet that is poor in quality and insufficient in quantity. Because of these factors, they tend to grow very slowly. In addition, their rate of growth is reduced by diseases, infection and parasite burdens. Typical and potential growth curves are shown in Fig 7.1. Environmental conditions also affect growth. The combination of high humidity and high temperatures, for example, reduces growth by depressing appetite and, thus, food intake. Lack of access to water can also affect growth through stress. This is less of a problem in goats than in sheep but in very high temperature conditions or where animals are in poor physical condition it can be an important constraint.

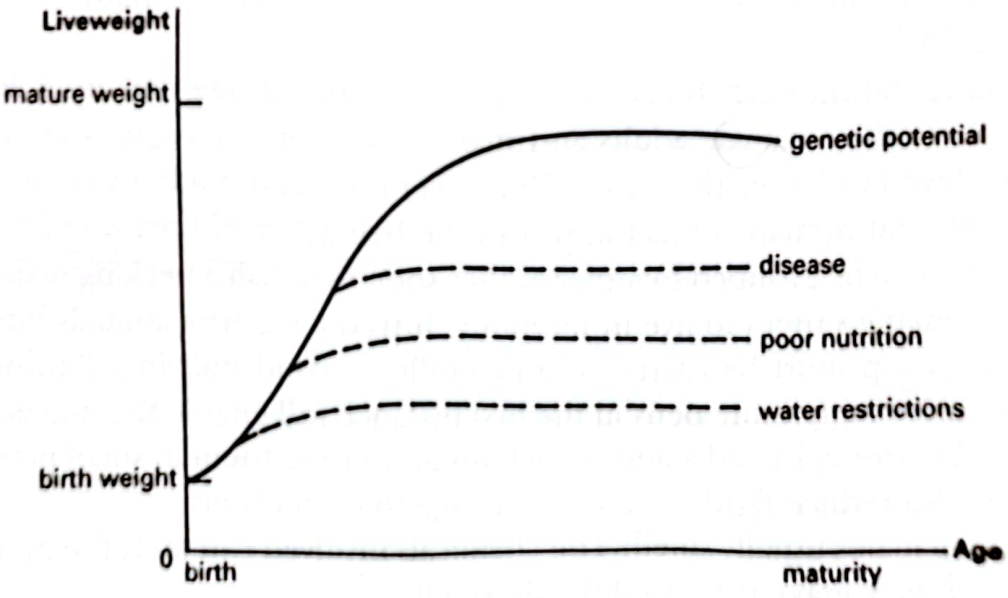


Fig 7.1 *Potential and typical growth curves*

Growth rates of young goats can vary from 20g to 180g daily although they are generally considered to grow more slowly than lambs. In many tropical conditions, growth rates are likely to be at the lower end of this range. Male kids tend to grow faster than females whilst females get fatter on a similar diet. On a good diet large breeds will grow much faster than small ones. When the diet is very poor this potential of larger breeds is not fulfilled and they have little advantage over smaller breeds.

1.1 Compensatory growth

The growth of a goat will, in normal circumstances, follow the graph pattern of Fig 7.2. In many countries lack of forage during dry seasons restricts actual daily growth or causes animals to lose weight. This may also happen during the high humidity of coastal summers. Once goats return to better feeding or better environmental situations they grow and recover weight at a much faster rate than one would expect from the quality and amount of food fed. This is known as *compensatory growth* and is one of the means by which goats can adapt to the diet available.

1.2 Castration

The castration of male animals is more important in helping the management of breeding than in changing the rate of growth of bucks. Castrated males are likely to grow slightly faster than females but also to produce fatter carcasses than whole males. Castration will reduce the strong male odour of bucks kept and sold for meat when they are more than one year old.

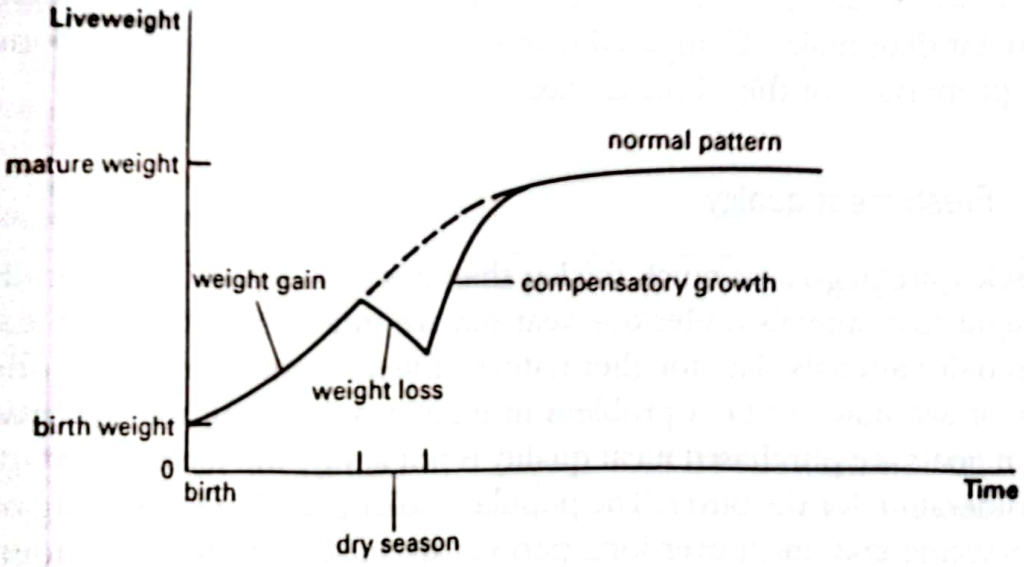


Fig 7.2 *Compensatory growth pattern*

1.3 Body composition

In very young goats the amount of meat or muscle is small in relation to the head, bones and internal organs. The proportion of muscle and fat in the body increases as the animal grows (Fig 7.3).

As fat is the last component of the body to grow, goats will only put on fat if sufficiently well fed. Once a goat has reached adulthood it will not increase the proportion of essential body tissues or muscle but will put on more fat if well fed. In contrast, underfeeding of adults leads to a weight loss of all tissues but the quantity of fat is reduced by the greatest amount.

1.4 Carcass yield

The *carcass yield* or *dressing percentage* of a goat is the weight of the animal that is sold for meat expressed as a percentage of the live animal's weight. In goats this percentage is usually between 35–50 per cent which is similar to sheep. The percentage is generally found to increase as animals mature. Male animals have a greater killing out percentage than females, and goats that have been well fed a higher percentage than those fed on an inadequate diet.

1.5 Carcass composition

Goats have much less fat below the skin and in the muscle tissues than sheep. They do, however, have more fat in the abdomen. Whilst sheep typically have around 30 per cent of their body as fat, goats have as little as 10 per cent. The age and sex of the animal will affect how much fat is laid down. Older goats are fattier than young ones and females have more fat than males. Compared with sheep, goats also have more bone as a proportion of the whole carcass.

1.6 Fresh meat quality

Muscle fibre in goats is much thicker than it is in sheep so it is generally thought that animals under one year old are much more tender to eat than older animals. The tougher nature of meat from animals over one year of age may not be a problem in many tropical countries because when goats are purchased meat quality is not always the most important consideration for the buyer. The popular cooking methods of stewing or pit roasting goat meat over long periods are ideal in providing tender, juicy meat. Rapid cooling after slaughter or rapid cooking can badly affect the eating quality of goat meat since these processes make the meat very dry and unattractive to consumers. In areas where eating goat

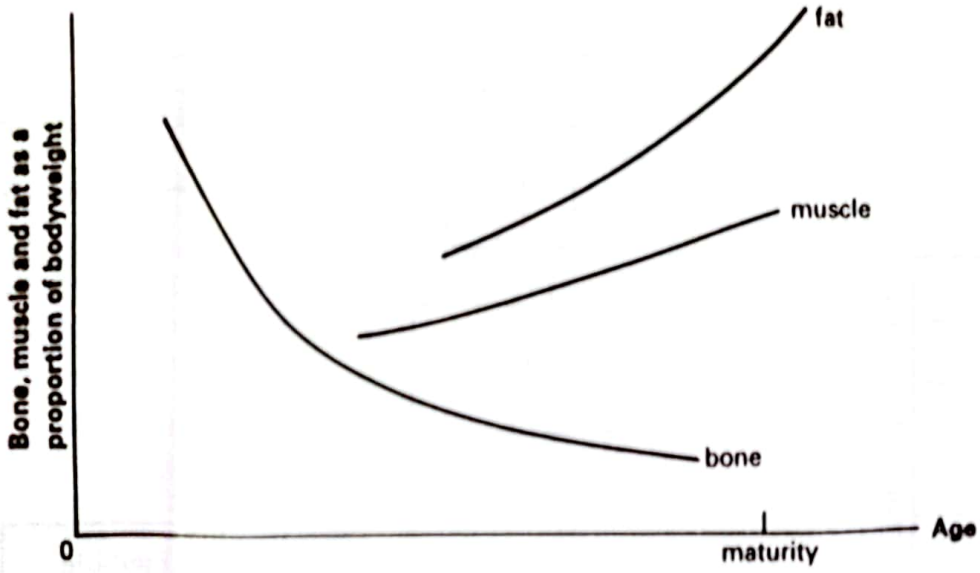


Fig 7.3 *Proportion of body as bone, muscle or fat*

meat is very popular, people mention the distinct flavour and palatability as major reasons for preferring it to sheep meat or beef.

2 *Meat*

The cash value of a goat carcass depends on the amount of edible parts available for sale. In parts of Malaysia this value is high because people eat, and therefore pay for, a large proportion of the by-products and edible offal as well as the meat. In the USA, however, only 25 per cent of the carcass may be saleable because only selected joints of meat are consumed. The remainder is sold as pet food or rendered to by-products such as meat and bone meal and attracts a very low cash return.

It is possible to identify three main types of meat sold – kid meat, meat from a young goat, and meat from an old goat (Table 7.1).

Table 7.1 Types of goat meat

	Age	Live weight/kg
Kid (Cabrito)	8–12 weeks	6–8
Young goat	1–2 years	18–28
Old goat	2+ years	28+

Cabrito is from very young kids and is popular in the West Indies, Central and Latin America where it is preferred to beef. Most goat meat in the world is, however, probably consumed as old goat meat. This

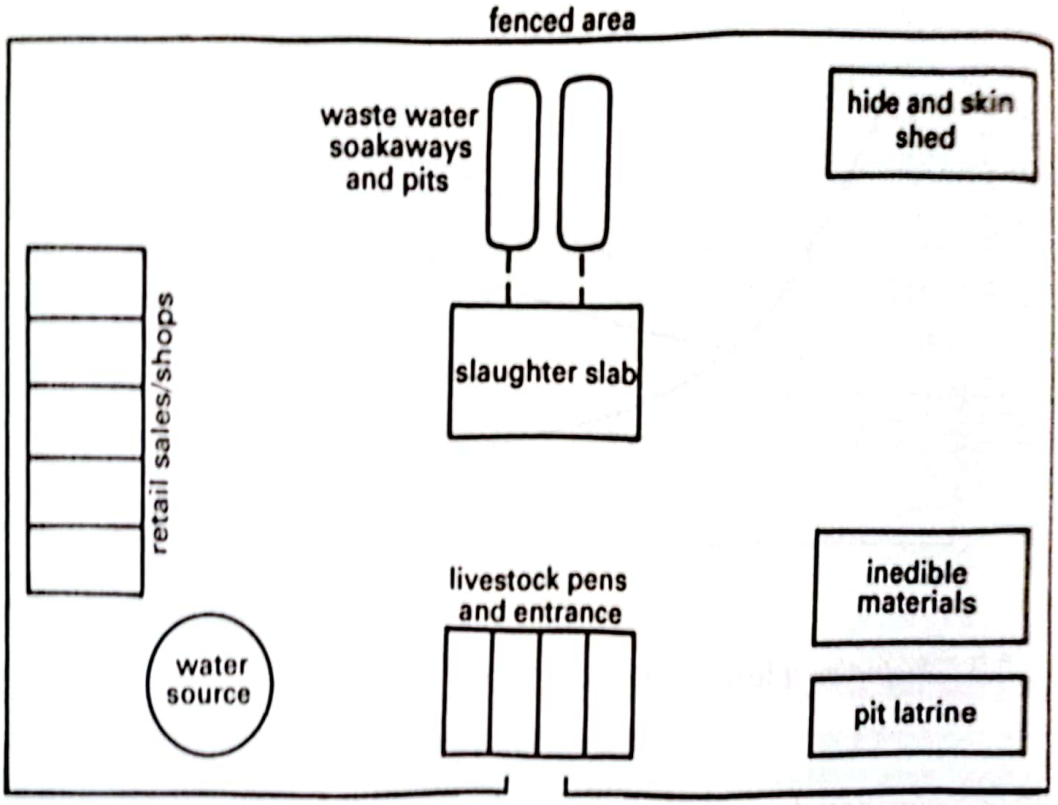


Fig 7.4 *Model village slaughter area*

comes from animals over two years old. As in S. E. Asia, offal may also be sold for human consumption. Goat meat is also very popular in stews and curries. With this type of meat, the quality or tenderness of meat is less important and so consumers will not pay high prices for goats.

2.1 Slaughter procedures and facilities

The majority of goats in rural areas are produced and consumed locally. Individual farmers will often slaughter their own goats at their homesteads for family consumption. Hygienic slaughter facilities are then minimal or non-existent, especially where the total number slaughtered and consumed is small. The need for better hygiene may, however, lead to the provision of simple village slaughter slabs (Fig 7.4).

A simple slaughter procedure should include the following key points:

1 Kill only healthy goats.
2 Use places away from houses and people.
3 Keep free-range animals and spectators away.
4 Stun the animal before slitting its throat.
5 Always hang the carcass up to bleed.
6 Bleed within 15 minutes of slaughter.
7 Use dry degutting process if water is *not* clean.
8 Separate skins and carcasses without delay.
9 Cook well and consume immediately after cooking.

Slaughter area

A model slaughter area is given in Fig 7.4 and provides the following simple facilities:

1 Livestock pens.
2 An easy to wash slaughter slab.
3 A supply of fresh uncontaminated water to wash the carcass, the slab and the butchery tools.
4 Shade and shelter in which to salt and cure skins and hides.
5 A separate butcher's shop and a store for edible offals.
6 Pit latrines.
7 A pit for inedible by-products.
8 A perimeter fence to stop dogs or people entering the slaughter area and contaminating meat or offal.

Equipment

The minimum equipment needed for slaughter and butchery would include:

1 Hammer or pistol for stunning.
2 Strong sharp knife.
3 Two hooks to hang up the carcass.
4 Containers to collect blood and internal organs.
5 A saw or hatchet.

Method of slaughter (non-Muslim)

A useful method of slaughtering could follow this procedure:

- Goats should be starved for the last 12–24 hours before slaughter.

1 Firstly, with the animal standing on the slab it is stunned by hitting it with the hammer or using the pistol to shoot it. The point of impact is at the top of the head just above and between the eyes (Fig 7.5).

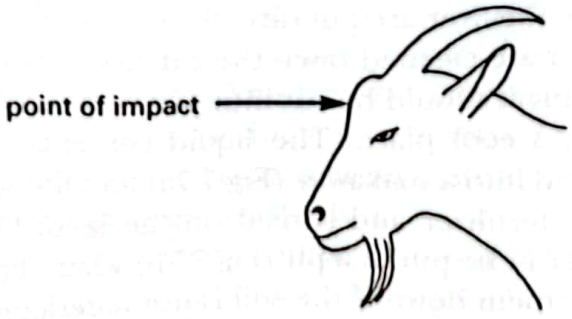


Fig 7.5 *The point of impact to stun a goat*

2 The sharp knife is stuck into the neck below the ear at the base of the jaw and pushed right through the neck. A cut is made down and forwards to cut the windpipe and blood vessels. Either the blood is collected in a container or allowed to solidify on the slab then collected.

3 The carcass is hung up off the ground using two hooks, one in each back leg.

4 The carcass is skinned with a sharp knife. Cuts are made in the following way (Fig 7.6):
   a) around each front foot and the inside of each front leg from foot to breast bone,
   b) in a circle around each back foot and along the back of each leg from foot to rectum,
   c) in a line from chin to rectum without piercing the gut cavity. The skin is then pulled off using your hands and starting at the hind feet,
   d) around the neck. The skin is then removed for washing and salting.

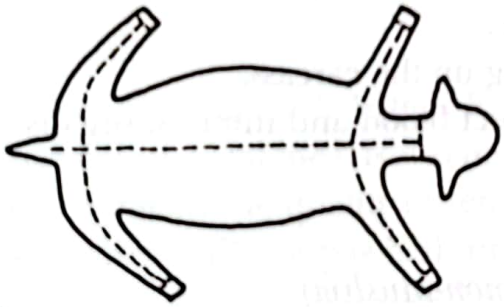


Fig 7.6 *Cuts to remove the skin*

5 The head is removed and hung off the ground preferably with a hook through the tongue.

6 The front feet are cut off.

7 The guts and internal organs are removed from a belly slit open from top to bottom without cutting the internal organs.

Edible organs like the liver are put directly onto hooks. Organs for sale or consumption are cleaned once the carcass has been washed and removed. The meat should be cut into pieces according to local custom and put in a cool place. The liquid contents of digestive organs can be washed into a soakaway (Fig 7.7a) and the solid matter saved as a valuable fertilizer and spread on the land. Organs and bones not required can be put in a pit (Fig 7.7b) where bacteria and fly larvae will break them down if the soil is not waterlogged.

A soakaway can be an ideal method of disposing of semi-liquid wastes and if constructed as in Fig 7.7a it will enable good hygiene

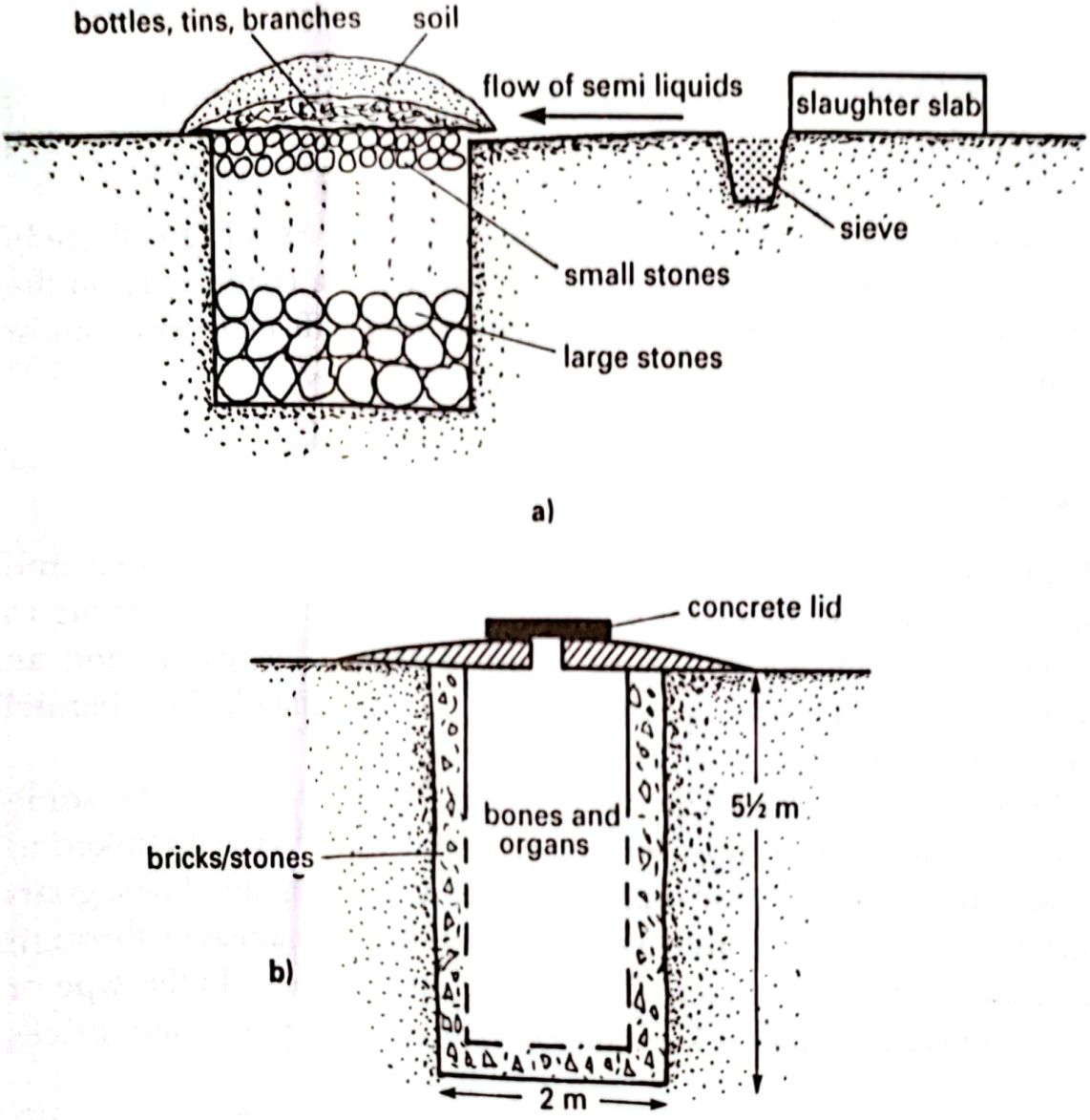


Fig 7.7*a) Soakaway b) pit for bones and organs*

levels to be maintained. Meat, guts, fat or clotted blood *should not* be put in the soakaway. A pit for inedible by-products constructed as in Fig 7.7b will also aid hygiene of unwanted products. However, such a pit will not operate well in the rainy season.

Slaughtering (Halal)

Animals slaughtered for consumption by certain religious peoples have modified slaughtering procedures in line with religious customs and beliefs. Both Jews and Muslims have no stunning procedure and include the saying of prayers in the ritual. It is important to the customer to keep meat from their system of slaughter separate from meat produced under non-Muslim slaughtering methods.

More sophisticated abattoirs may be available for slaughtering goats in or adjacent to large urban cities. These tend to be expensive to run and may not be economically justified in the difficult financial and physical conditions of the tropics.

This should be done in line with local custom and to suit the needs of those eating or buying meat. Normally a carcass would be cut up and consumed within 24 hours of slaughter.

Cutting around rather than across muscle fibres will greatly help hygiene. Cutting through muscle fibre leaves a very coarse edge on the meat and dirt or eggs laid by houseflies are very difficult to wash out or remove.

2.2 Markets and market channels

Traditionally, most goats are sold or consumed locally in rural areas and are often eaten by the owner's family. However, with people moving to cities the demand for goat meat in urban areas is increasing and an increasing number of animals are passing through a marketing channel to reach consumers.

In an organised marketing system (Fig 7.8) there is usually some assurance of a regular supply of animals for sale. This is usually linked to reasonable prices for good quality animals. As the diagram shows, goats may be sold direct to consumers locally and in urban areas or through auctions, traders or fatteners to consumers and butchers. In this type of system uncertainty and risk is reduced so that goats supplied and prices

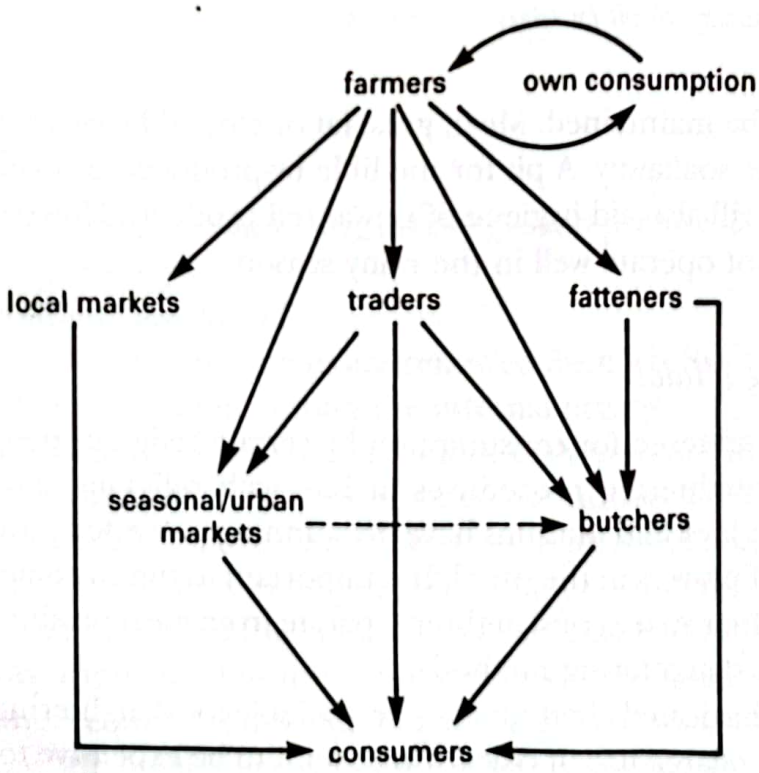


Fig 7.8 *Marketing channels*

received settle at a steady level over a period of time. In many tropical situations, however, the total consumption of any meat is low and the marketing of goats and goatmeat is very erratic or on a small scale. In consequence, prices tend to be very low and there is then little incentive for farmers to supply any animals and especially any good quality animals. An exception is found in Muslim countries prior to religious festivals when an increased demand for live goats pushes prices to very high levels.

In the tropics many goats are kept by pastoralists or nomadic people who sell only at specific times of the year. Goats may only be sold when keepers are forced to do so, such as in the dry season when forage is limited. These animals are unlikely to be in the best of condition and an irregularity of supply does not promote high prices.

Goats in the tropics are often sold as live animals to middlemen or traders who visit farmers as part of many business interests in which they may be involved. Prices paid are unlikely to reward the farmer producing good quality animals. The farmer has little opportunity to compare prices received by his neighbours as he would in the open market or at auction. Middlemen will sell the goats direct to the butchers or to other middlemen.

The auction type of market, although it can be a target for corruption and poor business practices, does at least allow prices to reflect real supplies of goats and real demands from customers in a competitive situation. This 'open' market system is common in India and the Philippines as well as in Africa. When farmers deal directly with consumers, higher prices are obtained by goatkeepers and lower ones by customers. This is because the middleman is cut out of the chain and his profit can be shared between the farmer and consumer. As most farmers have low labour costs, they can usually afford the time to wait for a buyer. Larger farmers usually have an advantage over smaller farmers in any open marketing system as they have access to resources such as transport or labour and with larger numbers of animals can often negotiate a better deal from middlemen or consumers. In general, most goats sold for meat are judged on appearance and health rather than by size and weight.

International trade and preferences

Unlike pork or beef, goat meat is not a food whose consumption is restricted or constrained by religious rules. Many Islamic, Indian, West Indian and African communities show great preference for goat meat over beef or sheep.

International export markets have recently developed. Australia and New Zealand now sell chilled and frozen carcasses into S. E. Asia, the

Middle East and the islands of the Pacific and West Indies. Whilst this chilled or frozen meat is seen as a different product compared to fresh goat meat, great export potential seems to exist in Mediterranean and Middle Eastern countries.

Large numbers of live goats are also traded between countries. Turkey, Syria and Somalia export large numbers of goats by road to the Arabian countries each year for the Eid religious festivals.

Marketing and transport

If goats are sold live in a market, it is important that they look to be in good condition. Goats that are moulting, lame, have lice or look sick should not be put forward for sale. It may even be worth washing or brushing animals to remove dirt or muck. If the animals are transported to market, the vehicle used should also be clean. Animals can be brushed down once they have reached the point of sale and should be tied and marked individually so that they can be clearly identified. They should be allowed access to food and water because sales can take a long time.

Pastoralists often walk large numbers of animals over very long distances to pastures and markets. A majority of goats are walked to market in Africa and Asia (Fig 7.9) where distances of 10km are commonly covered. Shortages of water and forage as well as dangers from predators and disease can lead to deaths and loss of condition during such moves.

Transporting goats by vehicle, train or boat is much preferred to walking them if the distances are large. For individual goats which are

Fig 7.9 *Goats for sale in Nepal*

used to being handled, loading and transporting is a relatively simple operation as long as they are restrained comfortably so that they cannot hurt themselves or other stock and so arrive in good condition. With large groups of animals or ones which are more difficult to handle, advanced planning is required. Goats are great climbers and will escape through the smallest gaps if given the opportunity. The following check-list should be followed.

1 Animals should be confined in an enclosure approximately the same size as the transport. The vehicle must then be positioned as near as possible to this area.
2 Hurdles, barriers or people can then be used to provide an escape-proof avenue from enclosure to truck. If a ramp can be provided from ground to truck the whole group can be herded in carefully. Alternatively they can be lifted up individually.
3 Tying one or two animals into the truck may encourage others to join them!
4 For very large numbers, animals must be separated into groups once in the truck. A group of 10 to 15 will avoid crushing or smothering. This can be done by tying strong but temporary barriers across the truck. Alternatively each animal can be tied to the side of the truck.
5 Animals must be protected during transport from excess heat, wind and rain but must have adequate ventilation.
6 Goats should be separated into groups e.g. big males, small kids, horned – to prevent injuries and bullying.
7 Goats should be moved without mistreatment, beating or excessive shouting because these actions cause stress which could lead to ill-health and possibly death.
8 If animals are transported over long distances, they must receive food and water before, during and after the journey, and be allowed a period to recover at the end. This is best done by allowing them a grazing period during the journey. If the journey is for more than 12 hours, the goats should be checked every two hours by the driver and allowed three hours grazing at the end to recuperate before they are sold. Each goat should have a minimum of 0.25 sq. m. of space during transportation.

8 Fibres and skins

1 *Fibre growth*

Fibre or hairs are produced by hair follicles. Hair is not considered live tissue as it has no nerve cells or blood vessels. Hairs are made of high protein keratin and so are similar in composition to nails and horns. The number of follicles on a developing goat foetus is determined in late pregnancy. The density of fibres is related to the number of follicles and the number of fibres in each follicle. The follicles are arranged in groups called bundles. In each bundle there are primary and secondary follicles. The primary follicles give long, coarse guard hairs which are hollow and often brittle. The secondary follicles give fine short undercoat fibres. Most goats have more primary than secondary follicles, the Angora being the exception.

2 *Goat hair*

Of the two coats which most goats have, the short fine underwool or down one is called *cashmere*. The single coat of lustrous, coarse non-hairy fibre which only the Angora breed grows is called *mohair*. Both mohair and cashmere are valuable products used in clothing manufacture. In practice, whilst most breeds have an undercoat of cashmere the quality and quantity of fibres do not make it economic to harvest. The outer coat is made up of ordinary or common hairs which are a mixture of straight, fine and coarse fibres. Their colours and lengths vary, but black and grey are very common. These are traditionally made into mats, tents, bags or rope (Fig 8.1). These outer hairs are also imported into Europe from West Asia to make brushes, felt, coarse cloth and carpets for motor cars. Much of this common hair is from cashmere-bearing goats which are clipped once the valuable cashmere has been combed out.

Pakistan is the largest exporter of common hair selling over 3,500 metric tonnes per year in three grades defined by length. The longer the hair length, the more valuable it is. Most common goat hair is clipped

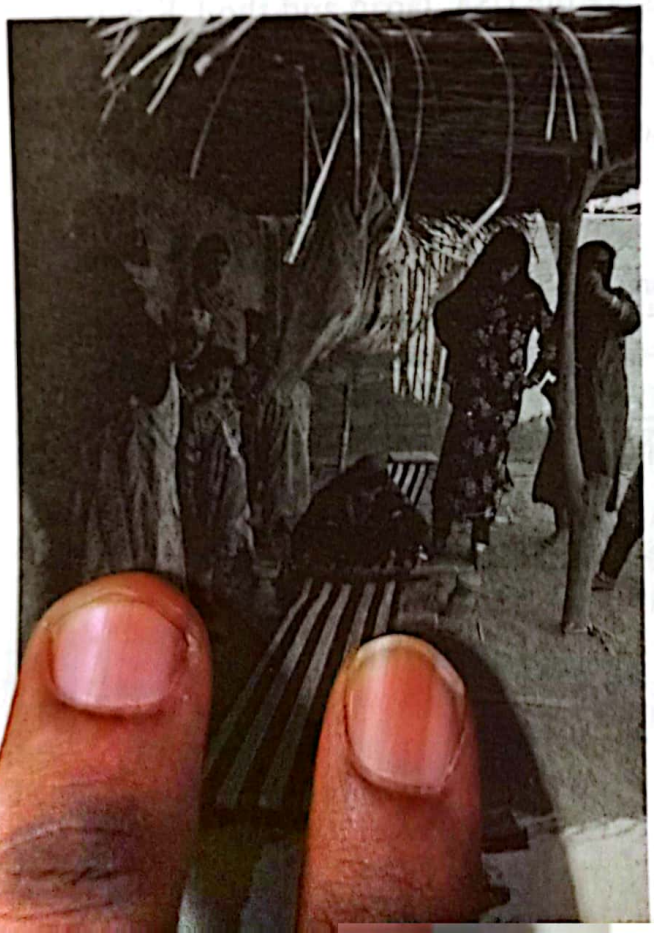
from the live animal, although a percentage comes from the skins on slaughter.

2.1 Cashmere

Cashmere fibre has scales on it and is not smooth like mohair. It can thus be spun as a pure fibre and need not be mixed with other materials. Cashmere therefore has a very high value. This varies relative to:

1 The length of the fibre.
2 The quality of the fibre, e.g. its diameter, uniformity, lustre, colour.
3 Yield per goat (Fig 8.2).

Like wool, raw cashmere can contain impurities which reduce its value. These must be removed before processing which can be expensive as well as damaging. It is important, therefore, to handle cashmere carefully to retain its purity. It should not be put in synthetic bags or tied with rope made from man-made fibres because the synthetic fibres can flake off into the cashmere and spread during processing. Because clothing manufacturers are interested in fine quality fibre to produce high quality cloth, they separate the coarse fibres out in a dehairing process. This reduces the yield to 45–50 per cent of the original greasy, raw weight. The Chinese, who are one of the biggest producers of raw cashmere, grade on the basis of average, clean fibre content. The quality of fibres also relates to the diameter of the fibre. All fibres must be elastic and



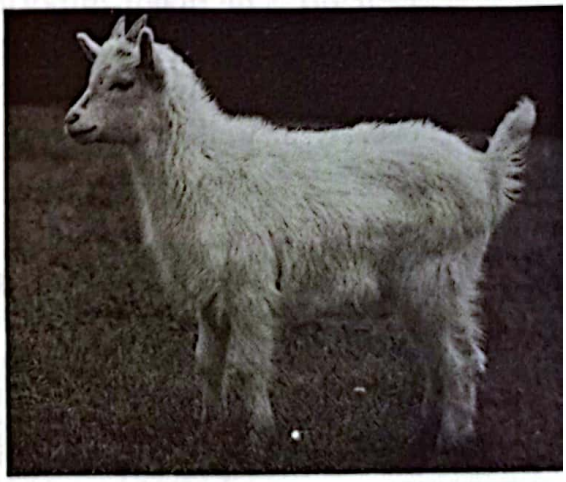


Fig 8.1 Left *Weaving goat hair mats in Oman*
Fig 8.2 Above *Kashmiri goat*

uniform along their whole length. When good quality yarn is produced, it is spun using at least 25 to 30 fibres. The diameter of individual fibres is measured in microns (1 micron = 0.001mm). Good quality fibres measure between 8 and 25 microns. Long fibres and ones of a uniform length are more valuable as they are much easier to spin into yarn. Fibre length is measured in centimetres. Lengths above 2.0cms are the most valuable.

The shape of the fibres is also important. Fibres vary considerably in their cross-sectional shape, with circular fibres being better than oval or flat ones. The colour of the fibre is of practical and commercial importance. The lighter the colour, the higher the price paid. This is because it is simpler to dye lighter colours when the final clothing colour is selected. The Chinese grade and sell their cashmere in white, grey and brown categories whilst the Iranians use white, cream, fawn and brown.

Cashmere is sold as a luxury fibre and clothing manufacturers require a soft lustre. Lustre is, however, difficult to measure and buyers rely on feeling the raw product for softness, lightness, bulk, warmth and moisture when they purchase. Other important factors in defining cashmere fibre quality include strength and elasticity.

World production and trade of cashmere

Annual world production of cashmere is estimated at 3000 metric tonnes. Most of this comes from Iran, China and the East Asian part of the former USSR. Smaller quantities are produced by Australia and New Zealand. The major importers are the USA, Japan and the UK where it is manufactured into luxury clothing including sweaters, scarves and overcoats. Cashmere clothing is very light, soft and warm. It does, however, wear well. In consequence it is very highly priced.

Table 8.1 Fibre lengths and diameter

Fibre	Country	Diameter (microns)	Length (cms)
Mohair	Turkey, S. Africa USA	24 – 45	10 – 25
Cashmere	China, Iran, USSR	15 – 19	2 – 8
Wool (merino)	Australia	17 – 25	6 – 12
Camel	China and Mongolia	16 – 25	3 – 5

Harvesting cashmere

Traditionally the down from cashmere goats is either combed from the goat in the spring or collected as it sheds naturally at the end of winter. Yields per animal are normally very small, 50–200g, but very valuable. Both methods produce uncut fibres together with outer coat hairs and pigmented fibres. Before the cashmere can be manufactured into cloth it must be sorted to extract these other components. If cashmere could be carefully graded at the point of production by the farmers they would receive a higher price for their product.

Cashmere goat fleece

The average length of outer fibres of a cashmere goat is 15cm (Table 8.1) with an undercoat of 6cm. The undercoat is normally a paler colour than the hair and a black goat, for example, will have a grey undercoat. Cashmere and Angora flocks have a higher proportion of white goats which is thought to be because of past breeding policies to provide fibre for textiles. Most ordinary breeds have a down undercoat but only the cashmere and some associated breeds produce sufficient fibre to make harvesting economic. In China cashmere goats yield an average of 125g (80–200g) with a quality of up to 13–16 microns. Coarser fibres originate from Afghanistan and Iran with quality at 18 microns. Yields from these animals tend to be higher than from those producing finer quality. Coarser breeds include the Russian Oreburg breed (220–375g) and the Don (450–1150g).

Fibres below 16 microns are usually used in knitwear and those above are used in cloth. Some very coarse fibres are mixed with wool in the manufacture of coats.

Cashmere breeds

There are four groups of cashmere bearing goats.

1 The western group from Asia Minor and the former USSR, e.g. Anatolian Black, the Don and the Kirgiz.
2 The eastern group from China, Mongolia, northern India and Pakistan, e.g. Mongolian and Kashmiri.
3 Redomesticated feral goats in Australia, New Zealand and northern Europe, e.g. Scottish and Icelandic goats.
4 Crossbred goats, e.g. Angora and Soviet mohair.

(See chapter 2 on breeds for details of the Anatolian Black, Kashmiri and Angora.)

2.2 Mohair

Mohair is the fleece of the Angora breed which is developed from the secondary hair follicles which are long enough to mask the primary fibres. It is used to make furnishings, rugs and blankets. The best quality mohair from kids is used for light-weight suits. The Angora breed is centred on Turkey but exports of live animals to the USA (Texas) and South Africa have resulted in significant populations developing there. Smaller groups are found in Australia, Argentina and Lesotho.

Table 8.2 Populations of Angora goats in various parts of the world

Country	Angora population in millions
Turkey	3
South Africa	6.3
Lesotho	0.85
USA	1.3

The Angora has also been used in crossbreeding programmes in India, Pakistan, Madagascar and Fiji.

Mohair quality and yield

Mohair fleeces grow in curly ringlets or flat waves to a length of 10–25 cm. Mohair is less fine than cashmere and averages a diameter of 24–25 microns (Table 8.1). The clip weight varies with husbandry and location. Typical annual yields per animal are shown in Table 8.3.

Table 8.3 Annual yields of mohair per animal

Turkey	1.5kg
Lesotho	5.3kg
USA	3 – 5kg

Shearing twice yearly will increase yield but also increases the percentage of *kemp*. Kemp is the hair produced by the primary follicles and is brittle and considered an impurity. It is possible to shear the fleece three times a year but because processors need a minimum of 11cm of staple for cloth production three cuts are likely to give staples that are far too short on at least one occasion. Undersize staple is sold at a lower price than longer staple.

Fleece weights are also affected by nutrition. Long fibre lengths do not mean higher fleece weights and very long fleece lengths cause processing problems. Overall quality is defined by:

- fibre fineness
- kemp percentage
- stain
- vegetable matter content (seeds).

Very young goats have more kemp than older ones.

3 *Hides and skins*

The hide or skin of the goat is small compared to that from buffalo or cattle but is a very valuable by-product if properly prepared and preserved. It can be worth 10 per cent of the total value of the animal. The most valuable skins are those that are strong, sound, thin and light because these are suitable for making fashion items like handbags and wallets. Thicker, coarser skins are made into shoes.

Some breeds, such as the Red Sokoto in Nigeria and the Black Bengal in India, are well known for the quality of their skins and are often kept solely for this purpose.

The value of any skin is reduced when care is not taken during the slaughter and curing process. Some skins are damaged when the goat suffers disease or physical damage and this will reduce their value. Good husbandry can therefore improve the value of this by-product by reducing damage from disease. Animals should also not be branded or injected on a site that will be prominent. It is better to brand on the lower legs and to give an injection on the neck, as these areas will not be part of the cured skin.

3.1 Practical skinning and curing

The skin is best removed from the freshly killed goat using a sharp round-ended knife. The traditional point-ended knife is liable to cause tears in the skin which reduces its value. The knife is used to slit open the skin but it is better to pull the skin from the carcass by hand to avoid any damage. Removal is easier if the carcass is hung from its back legs and still warm.

Skins should be cut as shown in Fig 7.6 (p. 116), where the animal is initially lying with its back to the skinner. If skins can reach a tannery within one day no treatment will be required to preserve them. Because in many situations in the tropics this is not possible the skins may well be dried and cured by a local villager.

3.2 Drying and curing in the village

If the skin is to be preserved, processing must begin immediately after slaughter. The cheapest and simplest method of curing is air drying. This must be done in a well ventilated situation away from rain and direct sunlight. The direct heat of the sun will cause any fat on the skin to melt or turn rancid. The hide should be suspended and stretched. If hides are dried on the ground the underside gets very humid and the quality of the skin is reduced. Air drying will take between 10 and 14 days. Skins can be suspended on frames or in rings of bamboo hung from trees (Fig 8.3).

Salt may be used to help preservation although it requires much labour. The salt is applied to the fleshy side of the skin and rubbed in at a rate of 30 to 40 per cent of the weight of the hide. The salt removes water from the skin and stops bacterial growth that will cause rotting. Sodium fluoride can also be added to the salt to restrict bacterial growth. When salting, a number of skins are usually stacked one on top of the other on a wooden pallett fleshy side up to allow excess brine to flow away (Fig 8.4).

The pile of hides is left for 7–10 days then restacked with the topmost hides at the bottom. This will encourage maximum impregnation of salt through all the hides. In the hot tropics salt is best applied without water. In the cooler tropics using water with salt is successful. This will, however, increase the weight of the skins which may make transportation a problem if the skins are carried, for example, by camel or donkey.

The hides of damaged skins can be made into a very good rope as happens in Botswana. Fish oil or animal grease – but not engine oil – will help soften the rope if rubbed in well.

A good quality well-cured goat skin will weigh between 1 and 2kg (Fig 8.5).

4 *Manure*

In intensive livestock units or where goats are collected together at night, it is possible to collect the animal droppings or manure for use or sale as a fertiliser or fuel source. Goat manure makes a very good fertiliser. The droppings can be mixed with forage residues, soil or urine to rot before use. If fresh manure is put directly on crops it may cause scorching resulting in plants shrivelling or turning brown. Removing manure from livestock areas is good practice in any event, as it stops parasite and bacteria build-ups. Composting the manure will improve its quality as a plant food. Traditionally, manure is left as a heap above ground level to allow bacteria to break down the products in the heat. In dry conditions,

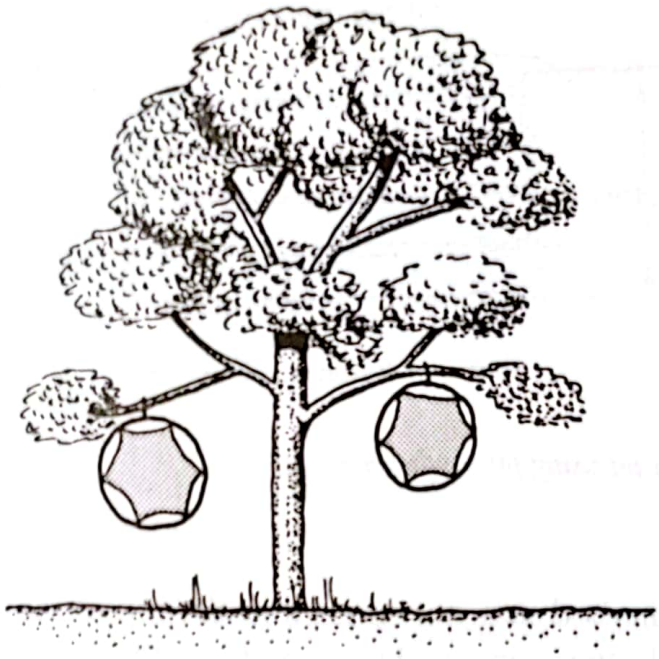


Fig 8.3 *Hides drying in trees using rings of bamboo*

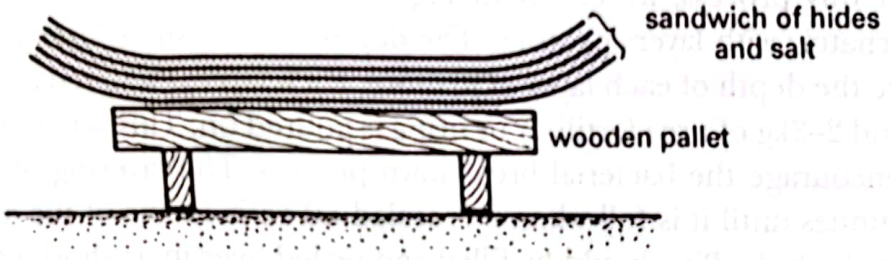


Fig 8.4 *Stack of hides curing on a pallet*

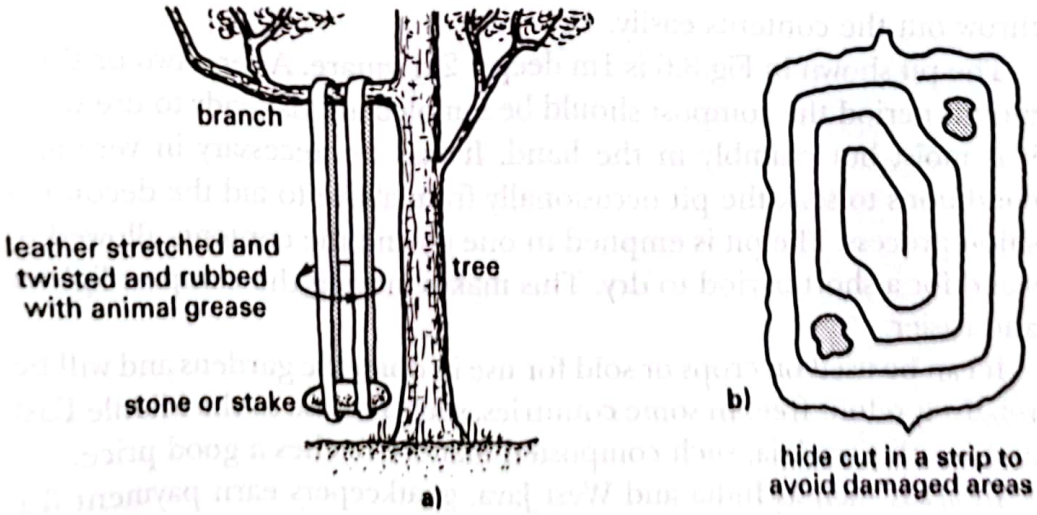


Fig 8.5*a) Softening the hide with grease b) cutting hide in strips to avoid damaged areas*

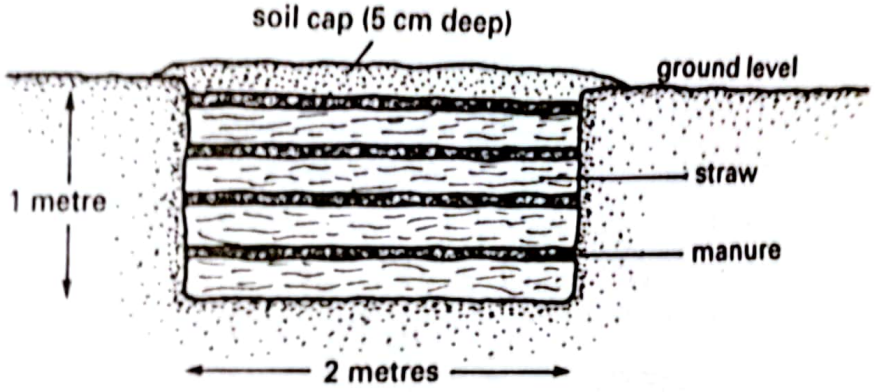


Fig 8.6 *Compost pit using pit sandwich procedure*

however, this method may not succeed as the top of the heap quickly dries out and bacteria are unable to perform the breakdown process because they do this best in warm moist conditions. An alternative method successfully operated in the arid Middle East is the *pit sandwich* procedure.

In this process, as shown in Fig 8.6, the manure is put into pits, alternately with layers of straw. The depth of each straw layer is usually twice the depth of each layer of manure. Each layer is watered as it is put in and 2–3kg of urea fertiliser or urine is poured on. This acts as a starter to encourage the bacterial breakdown process. The layering of the pit continues until it is full when it is sealed off with 15cms of the soil dug from the hole. Pits should be filled and sealed over in as short a time as possible and then left for 2–3 months for all the contents to rot down. The size of the hole is not important although it should be deep enough to retain moisture without being too deep so that it is below the water table. If hand dug it must not be too deep otherwise it will be difficult to throw out the contents easily.

The pit shown in Fig 8.6 is 1m deep × 2m square. After a two or three month period the compost should be sampled and is ready to use when it is moist but crumbly in the hand. It may be necessary in very arid conditions to soak the pit occasionally from above to aid the decomposition process. The pit is emptied in one go and the contents allowed to stand for a short period to dry. This makes moving the compost lighter and easier.

It can be used on crops or sold for use in domestic gardens and will be relatively odour free. In some countries, such as those in the Middle East and South East Asia, such composted manure fetches a good price.

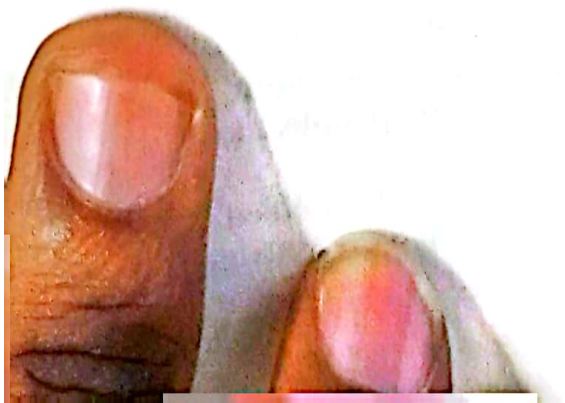
In areas such as India and West Java, goatkeepers earn payment for keeping their animals on ground that the landowner wishes to be fertilised and cropped. The dung and urine that the goats deposit is an integral part of the cropping system.

5 *By-products*

Besides the meat and skins the goat carcass yields a number of saleable products. These include:

- tallow (fat) used in soap manufacture or animal feeds
- meat, bone and blood meal used as a fertiliser when dry and in some countries as an animal protein feed for pigs and poultry
- horns and hooves used in handicrafts
- bone and gelatine used as food
- the guts used as sausage skins
- edible by-products – liver, kidney, heart, tongue, brains, spleen, stomach, testicles and udder, intestine, bladder, glands, lips, lung.

The amount of edible by-products from a goat varies between cultures. In S. E. Asia the total edible proportion of a carcass is over 60 per cent because many by-products are considered delicacy items. In parts of Africa the percentage is only 48 per cent.



9 Milk

In the tropics goats are rarely kept just for milk but goats' milk and goats' milk products are of great importance in subsistence agriculture. In temperate zones, pure dairy goats are more common and serve specific markets such as those for soft cheese. In the tropics most goats' milk is consumed as the fresh liquid. Whilst it is produced in relatively small amounts it is an important food for many subsistence farmers. The milk has characteristics that make it particularly beneficial to people who are allergic to cows' milk or who suffer skin conditions like eczema. In specific areas of the world such as the Middle East, milk is commonly made into products including soft cheese, ghee or curds that can be kept for longer periods of time than fresh milk.

Goats produce milk from the mammary glands in the udder. As with sheep, goats only have two teats whilst cows have four. Extra teats may be present but usually do not function. Milk is normally produced after the first kidding although some goats will start secretions before this and are called *maiden milkers*. Goats, unlike cows, can continue to lactate for up to two years, which means they do not have to be mated each year.

Milk is secreted into milk glands in the udder and stored there on a continual basis until removed by milking or suckling. It is then released or *let down* for milking in response to the hormone oxytocin. The natural mechanism that causes this *let down* is for the kids to be present to nuzzle and suckle the udder. The more frequently the suckling takes place the more milk will be produced. If milk is removed by hand milking then this *let down* is promoted by the familiar routine that the goat goes through prior to the milking process, e.g. giving food prior to milking, the noise when the milking bucket is moved or by calling the goat to the milking place. It is very important to maintain a precise routine otherwise milk yield is adversely affected. Sudden stress will also cause a decline in milk production because stress causes the secretion of the hormone adrenalin by the goat which restricts milk secretion. Such stress can be caused by unusual disturbances from people, dogs or traffic.

Some goats are very loathe to allow themselves to be milked. The presence of the kid may partially overcome this problem by assisting the

milker in obtaining all of the milk from the udder. Alternatively, the kid can be allowed to suckle that part of the milk left in the udder after hand milking which is difficult for the milker to extract.

1 *Milk production*

The majority of goats in the world are not kept for milk production but their milk is of critical importance as a food for kids. In smallholder situations, either some goats may be kept to supply milk for the home with the kids being sold or consumed, or alternatively milk production is shared between the nanny's kids and the family. In temperate countries such as France and the UK, a small number of commercially run dairy goat units exist modelled on cattle enterprises. These are highly specialised units, managed intensively and demand high standards of management to be successful. If liquid milk is produced for sale a *cold chain* may be required to enable the milk to be marketed in a fresh and hygienic state. A *cold chain* is a distribution system that transfers the milk from producers to buyers whilst keeping the milk cool and clean. It usually involves the use of refrigeration and lorries and is thus very expensive and inappropriate in many situations in the tropics. Goats' milk may be frozen and stored for short periods without undue effects on the milk.

If excess milk is produced and it cannot be sold or used locally before it starts to go bad, it can be made, whilst the milk is still fresh, into products such as cheese or yoghurt.

1.1 Lactation

The lactation curve for milk produced by goats is relatively flat (Fig 9.1). It peaks at 8–10 weeks from kidding whilst the cow or buffalo peaks at

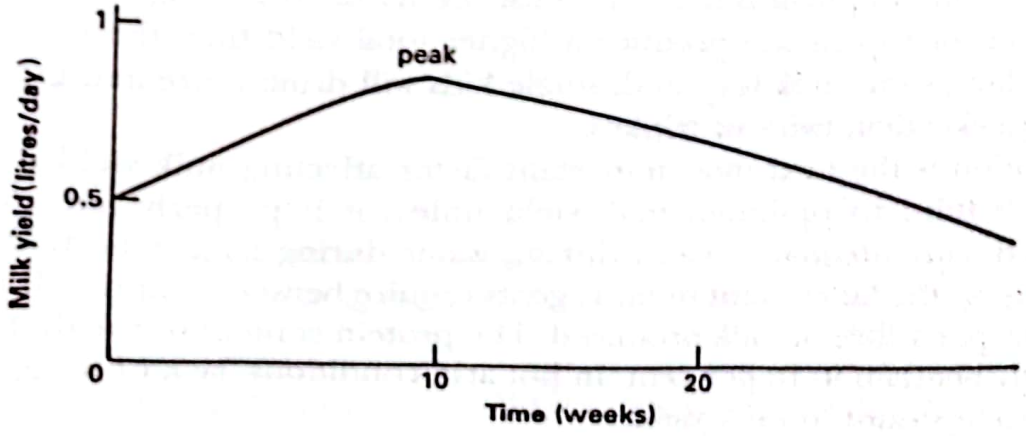


Fig 9.1 *Lactation curve*

4–6 weeks. The curve then gradually flattens off. For their size, goats have a higher relative yield than cattle or buffalo. This is partly because of the goat's relatively larger udder size and volume. The udder of a goat is a greater proportion of the total weight of the animal and contains a higher total quantity of secretory tissue than cows. Goats also have a higher metabolic rate related to body size. This leads to a larger daily intake of feed and larger production of milk per unit of body weight. (The net efficiency of utilisation of ME for Maintenance and Milk Production is 70 per cent)

1.2 Milk yield

Temperate dairy goats can produce up to 5 litres of milk daily with 1–2 litres being a good average. Non-dairy breeds in the tropics would typically give up to 0.5 litres. The factors affecting milk production include:

1 Body size and weight.
2 Age.
3 Udder size.
4 Litter size.
5 Nutrition.
6 Temperature and season.
7 Breed. (See also breeds in chapter 2.)

The breed and type of goat is the most important factor affecting milk yield. Larger, heavier goats can eat more roughage than smaller ones and may be more efficient at converting poor quality food into milk than smaller ones. Bigger nannies often store fat in the body before kidding which can be used to boost yield at the start of lactation. Goats that kid earlier in life tend to have a lower yield in their first lactation than those that kid after they are two years old. Goats that start milk production later in life are, however, likely to have a lower lifetime milk yield than early kidders. Dairy goats in temperate countries are normally first kidded at two years or older whilst many goats in the tropics kid before they are two years. Bigger udders have a higher production capacity but may be prone to physical damage whilst the nanny is grazing. Nannies with twins or triplets will produce a higher total yield than those with singles but as this milk is shared, single kids will drink more and grow more quickly than twins or triplets.

Nutrition is the next most important factor affecting milk yield. No goat will fulfil its optimum milk yield unless it is properly fed and provided with adequate clean drinking water during its lactation. Depending on the fat content of milk, goats require between 5 and 6MJ of ME daily per 1 litre of milk produced. The protein content of the diet is normally between 9–10 per cent. In hot arid conditions, lack of water is a major constraint to milk yield.

Different breeds have different yield potential and can be classified as dairy or non-dairy types. Saanen, Alpine, Toggenberg, Anglo-Nubian,

Table 9.1 Examples of yields and lactation lengths of unimproved goats found in the tropics

Breeds	Total daily yields/litres	Average no. days lactation
Angora (Turkey)	0.5	123
Barbari (India)	0.6	183
Katjang (Malaysia)	0.7	126
West African Dwarf (Nigeria)	0.3	126
Jamnapari (India)	1.5	170

Source: Devendra and Burns, 1983

Damascus and Jamnapari are all examples of dairy breeds. Within breeds, later maturing animals tend to be more productive. Older goats in their sixth lactation produce more milk than those in their first two lactations. After the sixth lactation, yield declines as body condition deteriorates and teeth are lost.

1.3 Composition

Goats' milk is made up of fat, protein, lactose and water. It has a pure white appearance when fresh. Typical figures for solids content are given in Table 9.2.

Table 9.2 Composition of goats' and cows' milk

Composition	Goat %	Cow %
Total solids	13.9	13.5
Fat	4.8	4.8
Protein	3.7	2.8
Lactose	5.0	4.6
Ash	0.85	0.74

Source: Devendra and McLeroy, 1982

Cows and camels have similar total solids to goats whilst sheep have a much higher total of fat and protein. The composition differs between breeds with, for example, the milk of African Dwarf breeds having total

solids of 17–21 per cent. The first milk produced after kidding is called *colostrum* and contains more protein and essential antibodies than normal milk. The antibodies are essential for the long-term health of the new-born kids. The composition of the colostrum changes to that of milk over the first five days of lactation.

Table 9.3 Colostrum composition Jamnapari breed

	Percentage (%)
Total solids	20.3
Fat	4.5
Protein	10.1
Lactose	4.5
Ash	0.9

Source: Devendra and McLeroy, 1982

Goats' milk has a higher percentage of small-sized fat globules than cows' milk. Because of this and the way it forms a fine curd in the stomach, it is much more easily digested by humans than cows' milk.

2 *Breeds*

Whilst many different breeds are milked and can produce reasonable yields, there are four specialist European dairy breeds that are described below. All four breeds have been used extensively worldwide for cross-breeding to improve the dairy production of indigenous goats. The Saanen, Toggenberg and Alpine goats all originate from the mountainous areas of southern Europe whilst the Anglo-Nubian originated from northern Africa.

2.1 Saanen

This is a pure white or pale biscuit coloured large goat (Fig 9.2). It has upright, erect ears and a short-haired coat. It is usually hornless. The body has a good dairy conformation with a well-formed udder. Adult females average 65kg, adult males 75kg. The latter measure 75–90cm at the withers. The breed has been exported to many areas of the world including India, S. E. Asia, the Caribbean, and West and South Africa. Daily yields of milk can reach 3 litres with a butterfat of 3.5 per cent. Kids make good meat animals.

2.2 Toggenberg

This is a chocolate brown or fawn coloured goat (Fig 9.3). It has white markings down the side of the eyes to the muzzle, on the ear tips and on the rump and tail. Legs are white below the knees and hocks. The males are normally hornless and have more hair than the females, especially on the hindquarters. Mature males weigh an average 65kg and females 50kg. Milk yield averages about 1 litre in the tropics. The breed is found in South America, South and East Africa and the West Indies.

2.3 Alpine

This is a black or rusty-coloured goat with white markings similar to the Toggenberg, although its conformation is like the Saanen (Fig 9.4). It has a short-haired coat and the ears are erect. Both horned and polled varieties exist. On average they measure 75–80cm at the withers. Adult males weigh 65kg, adult females 60kg. Daily milk yield is around 1 litre with a 3.6 per cent butterfat.

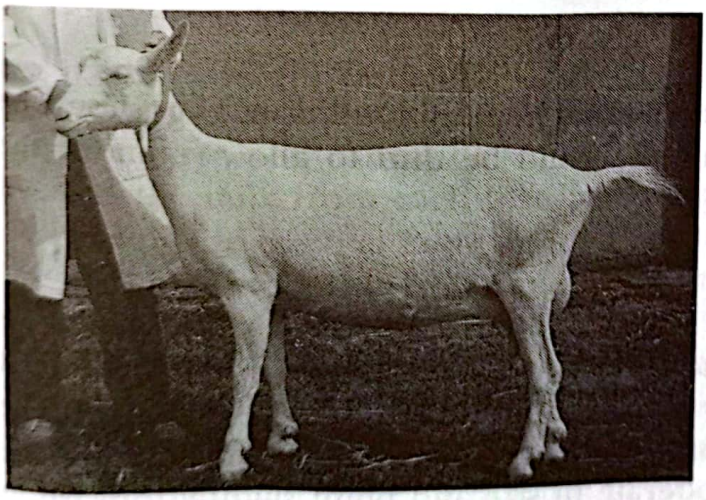
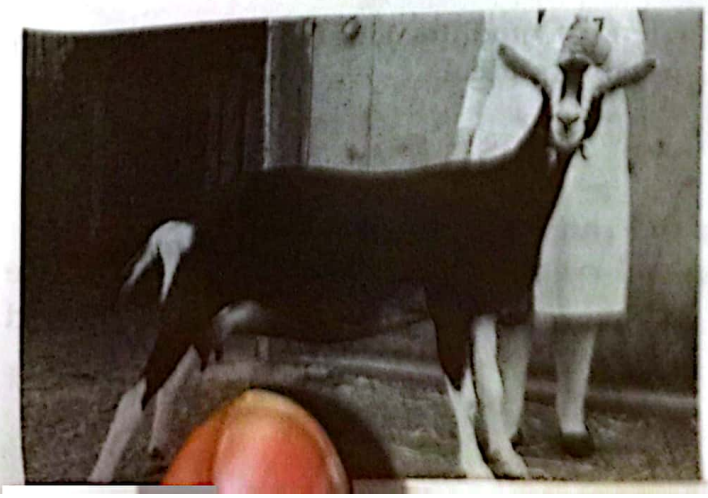


Fig 9.2 *A Saanen goat*
Fig 9.4 *The Alpine goat*

Fig 9.3 *A Toggenberg goat*
Fig 9.5 *An Anglo-Nubian goat*



2.4 Anglo-Nubian

This oriental looking goat is lop eared with a convex face and prominent forehead (Fig 9.5). It is hornless and has a short-haired coat patterned with shades of black, rust, brown and white. White patches on brown are most common. It is a tall goat measuring between 75 and 100 cm at the withers. Females exceed 60kg and males 70kg. The goat has been a very popular import into tropical countries to cross breed with indigenous stock. It is considered a dual purpose breed, being highly prolific and producing milk with a high butterfat content. Daily yields of 0.8–1.2 litres at 4.5 per cent butterfat are common.

3 *Points of a good milking goat*

3.1 Shape

A good milk goat should have a good conformation with a well-developed body. A wedge shaped body with a level back is considered to indicate an animal with good milking potential.

3.2 Feet

A milking goat must have feet in good healthy condition. Legs should be strong and straight. The thighs should be thin to allow room for the udder.

3.3 Udder

A large round or globular udder is a good indicator of milking ability. It should be carried well clear of the ground so as not to be damaged. The udder should appear as one whole organ rather than two separate halves. Teats should be moderate in size and point slightly forward as this type of teat is easier to milk or suckle.

3.4 Head

The head should be well carried, of medium length and wide. A full muzzle and well-developed nostrils are ideal.

3.5 Mouth

Adult goats over four years old should have eight front teeth on the lower jaw that meets the top pad evenly so that the goat can graze and browse effectively.

3.6 Attitude

Females should be alert and active with a non-aggressive behaviour and so consequently easy to handle. A soft shiny coat is a good indicator of health.

4 *Milking routines*

The more often goats are milked, the higher the total milk yield obtained. Twice daily is normal in commercial dairy units. Once daily is common for goats kept by subsistence farmers. Most goats are easily milked by hand, a process that will often take only a total of five minutes including washing and drying the udder. If the milking process takes a long time the goat will become impatient. A regular milking routine should be followed such as that given below.

1 Tie up or restrain the goat, offering her food if necessary.
2 Remove any dirt or dust from the udder and teats and the milker's hands with clean water. Dry the udder.
3 Use a clean bucket or bowl to collect the milk. Before use, the bucket or bowl should be sterilised or scalded.
4 Hold one teat in each hand.
5 Avoid pulling or stretching the teats or using vigorous up and down movements of the arms or hands.
6 Eject the milk from each teat by closing the finger against the teat and squeeze the teat between it and your thumb. Progressively close the first, second, third and little finger until the whole hand is closed on the teat. In this way the milk in the teat is progressively pushed down and squirted into the bucket. If the teat is small, use the thumb and one or two fingers rather than the whole hand (Fig 9.6).
7 Both teats may be milked at the same time but it is an easier rhythm to alternate left hand, right hand to eject the milk.

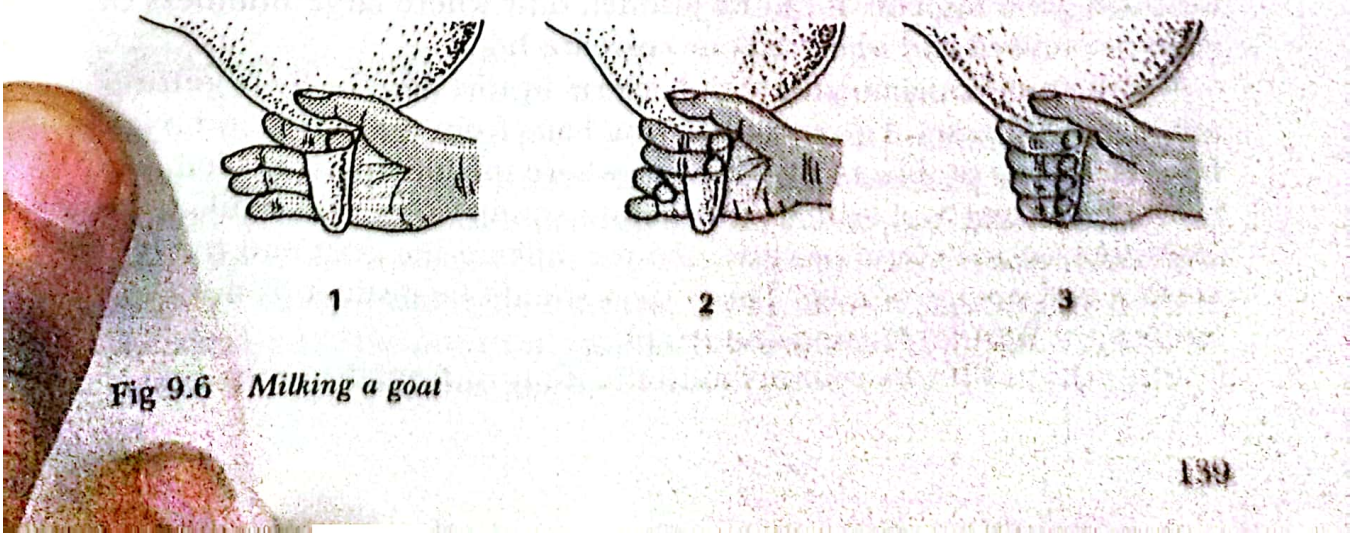


Fig 9.6 *Milking a goat*

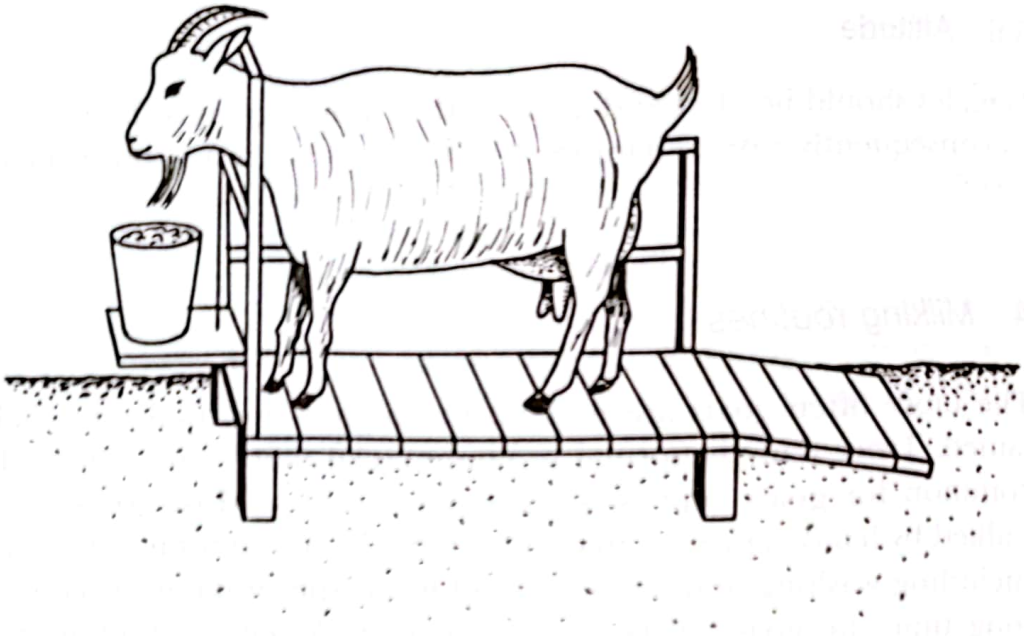


Fig 9.7 *A milking stand*

It can be tiring to milk more than one or two goats when they are standing at ground level. A simple stand that raises the goat up some 40–60 cm will allow the milker to sit on a stool during milking and thus reduce fatigue to the milker caused by stooping (Fig 9.7). Goats can be trained to stand on this type of milking stand or can be restrained by the head. Feeding them during milking will also persuade them to stand still!

In some intensive dairy flocks goats are milked using vacuum milking machines. These can be purpose made for goats or more likely machines designed for cows can be modified. Only two cups are required and they should be lighter than those used for cows. Milk may be collected into vacuum buckets or through a pipeline to a bulk tank. A vacuum of 40–45 KPa with 70–85 pulses per minute has proved successful. In a milking parlour goats can be milked from behind as well as from their side.

Milking equipment is very expensive and requires a lot of cleaning to maintain good hygiene. It can be justified only where large numbers of goats are milked and where labour costs are high.

Milk is easily contaminated with bacteria by dirt and/or hairs getting into the milk bucket. Trimming the long hairs from the udder and back legs will reduce problems. A clean area where the milking is carried out is also important and in many temperate countries health regulations insist that separate locations are used for milking the goat and for the cooling and storage of milk. These areas should be distinct from those used by the goat for feeding and sleeping.

Milk can absorb odours from foodstuffs, dung or from the entire male.

These odours taint the milk and may discourage people from drinking it. Separating the males from direct contact with milking nannies will reduce the possibility of male odours getting onto the nanny and then into the milk.

When a number of goats are being milked it is good practice to transfer milk from each animal to another location as it is finished rather than milking all of them into the one bucket. Milk should be filtered then cooled. Commercial filters are available but clean very fine cloth or muslin work perfectly well. If milk is to be stored for any period of time it needs to be cooled to 7°C as quickly as possible.

5 *Milk products*

5.1 Liquid milk

The majority of milk produced by goats for human consumption is produced in the traditional sector. Subsistence farmers do not generally record yields therefore the FAO figure for world output of goats' milk at 7236 tonnes is likely to be a gross underestimate. The individual production of milk on subsistence farms is low but the value of this food product to the family involved is immense. A small proportion of goats' milk finds its way onto the market locally, relatively little getting to larger urban areas.

To market goats' milk to city customers requires a large, continuous supply. Because most goats' milk comes from flocks with small numbers of goats this would mean a well organised collection system. Government or a co-operative could provide such a service. This has been done for buffaloes' milk in India. Alternatively large intensive units could be set up adjacent to the city. Both would require a distribution system that could move the milk from farmer to customer without it spoiling. This would probably mean a cold chain to keep the liquid milk cool. Goats' milk can be successfully frozen in polythene bags or in waxed cartons and will defrost without loss of nutritional attributes and still retain its composition and good appearance.

5.2 Other products

Goats' milk is also made into a variety of other products that include butter, yoghurt and sour milk. In some countries such as Greece and France, there is significant production of cheeses and butter. In France, prices for goats' milk and cheese are sufficiently high to allow industrialisation of cheesemaking and the marketing of such products to customers prepared to pay more for goats' milk products. The higher production makes this a sustainable market.

Fermented milk and yoghurt

Yoghurt is produced by fermenting milk with *lactobacillus bulgaris* and *streptococcus thermophilus*. This acidifies the milk and stops normal bacteria developing. Pasteurised milk is used, in the process heating to 72°C for 15 seconds and adding a 'starter' once the milk has cooled to 40–45°C. The starter is a small amount of yoghurt from the previous batch or alternatively a commercially available culture. Then the mixture is kept at this temperature for 90 minutes and subsequently at 10°C for eight hours before being eaten. Yoghurt is best made in plastic pots, glass or stainless steel containers which must be sterilised before use to kill unwanted bacteria that will make the yoghurt go bad. In the Middle East *leben* and *ajran* are popular yoghurts. *Doughe* is also commonly eaten and is a yoghurt with added water and salt.

Butter and ghee

Butter is made from goats' milk in countries such as Iran. It is very white in colour and is produced by churning the cream from the milk. Cream can be collected over several days as long as it is stored at 10°C. At this temperature the cream will ripen. No new cream should be added in the 12 hours before butter making.

The cream is then placed in a receptacle such as a goatskin. This should not be more than about one-third full. The cream should then be churned slowly and gradually increased to 40–50 revolutions per minute. This action produces heat which makes the butter oily. This can be avoided by cooling the contents to 15°C by standing the vessel being used as a churn in a bucket of cold water. When the cream thickens, 100ml water is added and the contents again churned. This process is repeated several times until the solids (butter) separate from the liquid (buttermilk). In commercial production, stainless steel utensils are normally used but at farm level receptacles made from goatskins are very popular. Pouring boiling water (scalding) on the butter-making utensils immediately before use will improve hygiene and standing any wooden equipment in salt water (brine) will prevent the butter sticking to them.

Ghee or rendered butter is very popular in the Middle East and Asia where it is either eaten or used in cooking. It will keep for long periods and is produced by boiling the butter or cream to remove the water.

Cheese

Goats' cheese is produced in many countries particularly around the Mediterranean coastline. Fresh, soft or hard cheeses are all made to meet consumer tastes and local tradition. They can be made from whole

milk, cream or from the milk when the cream has been skimmed. Fresh or lactic cheeses are made or eaten the next day whilst soft cheese is unpressed and consumed later. Hard cheeses are produced in the same way as soft cheeses but are then placed in moulds that are pressed to force out more water as described below.

Fresh cheese

This is also called lactic cheese because of the formation of lactic acid during the preparation. The cheese is made by allowing the milk to sour for 24–36 hours at 25°C. In tropical countries this period may be as little as 1–2 hours. The longer the period the creamier and less coarse the cheese. A small quantity of rennet can then be added to help separate the solids (protein and fat) from the liquid (whey). Rennet is a natural substance found in the abomasum of kids, lambs or calves.

Once the separation process is complete the liquid is drained from the solids (also called curds) through a cloth resting inside a plastic bucket and the solids are placed in a mould to give the cheese shape. Fresh cheese is usually eaten the day after being produced. This type of cheese is very mild in flavour and contains up to 70 per cent water. In Latin America there is a popular fresh cheese called *Queso Blanco.*

Soft cheese

Soft cheese is started in the same way as fresh cheese but then has a ripening period of between five and 30 days. This ripening process is controlled by enzymes from microbes that develop in the cheese. In many cases the microbes are added as with the French cheeses Sainte-Maure and Valencay where *penicillium* is used.

The characteristics of each cheese are determined by the duration of curding and length of ripening, the bacteria used and the level of temperature.

In Greece a soft cheese called *feta cheese* is popular. It uses a mixture of goats' and sheep's milk. It is rapidly curdled and the curd stirred and packed in moulds. These are then cut into big lumps, salted and put into wooden kegs. The cheese pieces are then washed and drained and stored in brine in other wooden kegs for one month at 12°C before being ready for consumption.

Hard cheeses

These are often produced in warm areas or mountainous regions.They are produced in the same way as soft cheeses except that once the drained curds are placed in moulds they are pressed to squeeze out more of the moisture. Once dry, the cheese is stored and turned each day until ripe. This takes about two months. Cheesemaking requires experience, skill and very clean equipment.

6 *Milk and diseases*

Milk is an ideal medium in which many disease organisms will grow and may then be transmitted to other goats and possibly humans. It is, therefore, extremely important to keep it as clear of bacteria as practical. Some diseases are very dangerous to humans. Two examples include tuberculosis and brucellosis, also known as undulant fever, which can cause sterility. Adequate pasteurisation of the milk will kill such bacteria.

6.1 Sterilisation

If the utensils used in collecting, storing or processing milk and milk products are not cleaned and sterilised, contamination with dirt and unwanted bacteria will spoil their quality and keeping time. Containers should be of stainless steel or tinned metal. Plastic is usually cheaper and can be used but will harbour bacteria in any scratches which makes cleaning more difficult. After use all utensils should be rinsed in cold rather than hot water, scrubbed with a detergent and finally rinsed in hot water. Wooden articles should be rinsed with cold water then scrubbed with hot water and then scalded with boiling water. Cloths must be washed and boiled after each use.

All utensils must then be sterilised using chemicals or steam. Steaming can be undertaken by heating a bath containing a shallow depth of boiling water over which the utensils are suspended on a rack.

Commercial detergents and sterilisers are costly and care must be taken to follow the manufacturer's instructions and dispose of them and their runoff after use so that damage is not done to the environment. Particular care is required to avoid killing fish and plants or polluting watering points for people and animals. If chemicals containing hypochlorites are used then equipment must be rinsed with clean, cold water after their use. If there is a long period between using the equipment then it should be sterilised after use and immediately prior to the next milking or cheesemaking session.

Remember that the cleanest water available should be used at all times.

Glossary

Abomasum Fourth and last stomach of a ruminant
Abortion Premature end of pregnancy
Acute Arising suddenly and very severely
Ad-libitum Freely available (food)
Agro-by-products By-products from agro-industries
A.I. See **Artificial insemination**
Anoestrus Point when a female does not come on heat and show oestrus cycles
Antibodies Blood proteins that help prevent diseases
Anthelmintic Chemical/drug that kills parasitic worms
Arid Area that receives very little annual rain and so has poor vegetation growth
Artificial insemination (A.I.) Method of collecting semen from male goats and putting it in the female's reproductive tract
Bacteria Tiny micro-organisms. Various types, some live in the rumen and play a vital role in digestion. Some cause disease and others are used in making cheese and yoghurt.
Barren Non-breeding female usually because of age or disease.
Billy Male goat (or buck) older than a kid
Body condition Indication of fitness of animal
Breed Population of goats that have a distinctive characteristic that is carried genetically. Also the ability to have young
Buck Male goat (or billy) older than a kid
Burrs Blunt points on a hypodermic syringe
Browse Way goats nibble a range of young twigs, shoots or leaves from trees and bushes. Also refers to the materials eaten
By-products Secondary product of a process, e.g. straw from a cereal crop
Carcass The goat's body that has died or been slaughtered for meat
Carrying capacity The number of goats that can live on a piece of land for a given period
Castration Process to stop the testicles of the male functioning
Cervix Part of the uterus that joins the vagina
Chronic (Of a disease) developing slowly or over a long time
Chewing the cud Chewing the regurgitated contents of the rumen
Cold chain A system of distribution that usually uses refrigeration to keep drugs or milk cool and so preserves them
Colostrum Earliest milk from a nanny that contains antibodies and nutrients
Concentrate A high energy food

Conception Implant of fertilised ova or egg that grows into the foetus
Condition scoring A method of assessing the body condition of a goat
Cudding Action of chewing the regurgitated contents of the rumen
Crude protein The nitrogen content of food × 6.25. Expressed as a percentage
Culling Discarding unwanted goats from a group usually because of old age, disease or not breeding
Curing Using salt or heat to preserve goat hides
Dam Mother goat
Deficiency Insufficient, e.g of a mineral or vitamin in a diet
Doe Female goat older than a kid
Dressing percentage That amount of the goat that is sold as a useful product (e.g. meat) after slaughter
Dwarf Very small or short legged
Dystocia Problems in kidding
Environment The conditions and surroundings in which a goat lives
Enzyme Made of protein and helps speed up chemical reactions
E.T. Embryo transfer
Exotic Goat brought from one region to another
Extensive A system with a small number of goats grazing a large area
External parasites Those parasites living on the outside of the goat
Feedstuffs Animal foods
Fertility Able to produce young
Flushing Feeding nannies extra, prior to mating, to increase the number of kids born
Foetus Kid carried in the uterus prior to birth
Fostering Getting a nanny to rear a kid that was produced by another female
Goatling Female goat under two years which has not yet kidded
Graze Eating growing vegetation, e.g. grass
Heat Physical condition when the nanny will stand to be mated
Helminth Internal parasitic worm
Hormone Chemical substance produced in a gland then transported in the blood to a tissue or organ upon which it has an effect
Incisors Chisel-edged teeth at the front of the mouth used for grazing
Intensive Flock of goats kept on a small area of land
Internal parasites Parasites that live inside the goat's body
Intramuscular Into the muscles, as with injections
Kidding percentage Number of kids reared compared with the number of nannies exposed to the buck
Kidding interval Number of days between two successive kiddings
KPa Kilo-pascals, units of pressure
Lactation The period during which the nanny is in milk
Larvae Immature stage of parasites

Lesion Damaged area of tissue caused by disease or injury
Litter size Number of kids born per nanny at one kidding
Lop ears Long ears that hang down the side of the head
Maiden milkers Females that start secreting milk before their first kidding
Maintenance State of existence without production; or the amount of food required for maintenance
Metabolisable energy (ME) The amount of energy available from food
Micron Unit of length equal to 10^{-6} metre
Migratory The moving of animals to different areas, sometimes at different times of the year
Mismothering When a young kid is taken by a nanny not its mother
Nanny Female goat (or doe) usually sexually mature
Nomadism A system where herders and their goats move from one temporary settlement to another.
Oestrus When the nanny is on heat and will stand to be mated
Offspring Kids born to a nanny
Ovary Two female reproductive organs that produce the eggs
Pastoralists Herders who keep animals in grassland areas, subject to seasonal growth
Polled Hornless goats
Prolific Large number of kids born in a litter
Protein Essential part of a goat's diet, protein contains nitrogen
Puberty Time when the goat becomes sexually viable
Rectum Final part of gut
Roughage Food with a high fibre content and low energy
Rumen First, largest stomach of ruminant
Ruminant Animals, including goats, that can use fibrous foods, chew the cud and have a four section stomach. Also sheep, cattle, camels, deer
Scrotum Pouch of skin containing testicles in male mammals
Semen Thick whitish fluid containing spermatozoa that is ejected from the penis of the male
Smallholder Farmer with very limited resources of land and livestock
Stall feeding Feeding of goats in a confined area without grazing
Service interval Period from kidding to next mating
Scouring A watery diarrhoea
Stocking rate The number of goats on a certain area of land
Subcutaneous Under the skin, as with injections
Succulent foods Foods containing a lot of water
Supplement Food given to goats as an extra feed to their diet
Symptom Appearance or behaviour of a goat subject to a disease
Toggles/tassels Small folds of skin found under the neck of some goats
Testicles Two glands within the scrotum that produce the spermatozoa

Tethering A system of tying up a goat to restrict its grazing area, with, for example, a rope around the neck

Toxic Poisonous

Traditional A thing done in the same way for many years

Transhumance The seasonal practice of moving animals between two areas of different climatic conditions

Uterus Part of the female reproductive system that houses the growing foetus during pregnancy

Weaning Separating the kid from the nanny so that it cannot drink milk

Withers The highest part of the back behind the shoulders

Yearling Goats between one and two years old

Yield Quantity of product (e.g. milk or fibre) produced over a given time

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