CHAPTER 1

Introduction

1.1 Historical background

Goats have helped people to survive and thrive for countless generations. The goat (*Capra hircus*) is thought to have been the first animal to be domesticated for economic purposes. Evidence suggests that domestication took place about 7,000 BC in south-west Asia, on the borders of present-day Iran and Iraq, where agriculture was already advanced. From there goats spread into all the tropical zones and most temperate areas. Now there is hardly a climate zone without goats.

Immediately after domestication, physical differentiation into breeds and types began. Early physical changes affected the ears, horns, colour, and hair type. These changes arose from natural mutation and from selection by goat keepers within the environment in which goats were reared, usually in relative isolation. Early goat keepers must also have selected for the production characteristics which were appropriate to their needs. New blood probably entered goat populations when people migrated for economic reasons or in times of conflict. There is a huge range of size, colour, and hair type among modern breeds of goats.

1.2 Current status

There are now estimated to be about 592 million goats in the world. Goats have shown themselves to be extremely adaptable animals and now are found as far north as Scandinavia and as far south as South America. They can be found at very altitudes. The long-haired Pashmina goats can live in the high Himalaya, while dwarf goats are able to thrive in the humid forests of West Africa.

Table 1.1 shows that the vast majority of goats (more than 90 per cent) are found in the developing countries of Asia, Africa, and South America. Goats in developed countries are really of minor agricultural importance. There are dairy goat industries in France and Switzerland which specialise in cheese-making, but otherwise
goats are kept by enthusiasts, partly for profit, but also for pleasure. However, in developing countries goats are of very great importance. Large flocks, of several hundred, are kept by the pastoralists of Asia and Africa, and millions of farmers keep goats in small numbers on small farms.

Table 1.1 Goat population estimates

<table>
<thead>
<tr>
<th>Area</th>
<th>Population (million)</th>
<th>Percentage of total population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>359</td>
<td>60.6</td>
</tr>
<tr>
<td>Africa</td>
<td>172</td>
<td>29.1</td>
</tr>
<tr>
<td>South America</td>
<td>23</td>
<td>3.9</td>
</tr>
<tr>
<td>Europe</td>
<td>14</td>
<td>2.4</td>
</tr>
<tr>
<td>North America</td>
<td>16</td>
<td>2.6</td>
</tr>
<tr>
<td>Former Soviet Union</td>
<td>7</td>
<td>1.2</td>
</tr>
<tr>
<td>Oceanic</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>592</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

1.3 The role of goats in developing countries

The contribution of goats to the people and economies of developing countries is obscured by several factors combining to give an underestimate of their true value. Firstly, estimates of goat numbers are usually inaccurate. Most goats are kept in developing countries which often cannot afford to carry out a regular livestock census and so they are rarely, if ever, directly counted. Cattle are more likely to be counted, but goat numbers are often mere guesses. Goat products seldom enter a formal marketing system, and so the goat's contribution to the rural and national economy tends to be grossly underestimated. In addition, goats are usually kept by poorer people, often tended by women, who seldom have a voice in national discussion. For all these reasons goats, and the people who keep them, are accorded a low status and given a low priority in national development. They are thought of as representing an old, primitive, low technology. What people want is new, sophisticated, high technology. In many countries there is even propaganda against goats. They are wrongly accused of destroying the environment, and prejudice has built up against them. As a result, little attention has been paid to goats by politicians, policy-makers, development administrators, and researchers.
The role of goats in developing countries

Table 1.2 Goat products and services

<table>
<thead>
<tr>
<th>Products</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>Pack transport</td>
</tr>
<tr>
<td>cooked blood</td>
<td>Draught power</td>
</tr>
<tr>
<td>soup</td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>Medicine</td>
</tr>
<tr>
<td>fresh sour</td>
<td>meat and soup for a range of conditions</td>
</tr>
<tr>
<td>yoghurt butter</td>
<td>milk for ulcers, allergies and lactose intolerance</td>
</tr>
<tr>
<td>cheese</td>
<td>butter for wounds</td>
</tr>
<tr>
<td>Skins clothes containers tents thongs</td>
<td>aphrodisiacs</td>
</tr>
<tr>
<td>Hair cashmere mohair coarse hair tents judges' wigs fish lures</td>
<td>Cosmetics</td>
</tr>
<tr>
<td>Horns Bones Manure for crops fish</td>
<td>Control of bush encroachment</td>
</tr>
<tr>
<td></td>
<td>Herding guide for sheep</td>
</tr>
<tr>
<td></td>
<td>Cash income</td>
</tr>
<tr>
<td></td>
<td>Security</td>
</tr>
<tr>
<td></td>
<td>Gifts</td>
</tr>
<tr>
<td></td>
<td>Loans</td>
</tr>
<tr>
<td></td>
<td>Religious rituals</td>
</tr>
<tr>
<td></td>
<td>Pleasure</td>
</tr>
</tbody>
</table>

Goats provide their owners with a vast range of useful products and services. Some of them are listed in Table 1.2. They can be regularly milked for small quantities of milk. In harsh environments, goats often produce milk when cattle have dried up. Goat milk is highly nutritious and has a similar nutritional profile to human milk, containing 4.5 per cent fat, 4.0 per cent lactose, and 3.0–4.0 per cent protein, depending on the goat’s nutrition, breed, and stage of lactation. The higher proportion of short- and medium-chain fatty acids, compared with the milk of other livestock species, allows goat’s milk to be digested easily by infants and those with digestive problems. Milk is an excellent source of calcium and phosphorus for growing children and can also
Introduction

provide a vital supply of vitamin A, which is often deficient in the diets of infants in developing countries. Goats' small size makes them ideal to slaughter for a few people at family celebrations or during religious holidays.

In addition to providing milk, meat, skins, and hair, goats have several important economic functions. They are relatively cheap to buy. Flocks can be built up until they contain many goats, which spreads the risk inherent in livestock ownership. It is not sensible for a family to put all its savings into one valuable cow or buffalo, when several goats could be purchased with the same money. Goats are often used as a first step up and out of poverty. Once the family has acquired additional resources, part of the goat flock can be sold and replaced by a large ruminant.

In marginal cropping areas, farmers will often try to keep livestock as an insurance against crop failure. If all or part of the crop fails, cattle or goats can be milked, or sheep or goats sold or exchanged for grain. Such mixed farming is an important drought-survival strategy. However, in some drought-prone parts of Africa this strategy has been used to the limit and has now broken down. Selling the last animal leaves families vulnerable to the vagaries of the weather. Many of Africa’s famines arise when this dual strategy irreparably breaks down.

Goats reproduce very fast. Most tropical breeds regularly produce twins and sometimes triplets. A small flock can quickly expand until it forms a major part of the family’s capital assets. Goats can regularly and easily be sold for cash and can either be part of a regular cash income or be sold in times of urgent need, such as sickness, death, or the payment of school fees. Goats, being small, can be looked after by young children.

Goats are kept in a wide range of different production systems. Most of the important systems are described in Chapter 2. At one extreme they are kept in large numbers, in extensive systems, by pastoralists grazing common pastures; at another extreme they may be intensively managed, permanently housed in specially-constructed houses, fed by supplies that are cut and carried to them, as in Java, Indonesia. Their hardiness means that they are often kept by people living in marginal agricultural areas, where they are particularly important.

1.4 The environmental question

There has been much propaganda against the goat, and the animal has frequently been used by politicians and bureaucrats as a convenient scapegoat for the environmental degradation caused by human activity. Goats are often blamed for the destruction of vegetation, when the real culprits are people and the overuse they make of vegetation in fragile environments,
through tree-felling and over-grazing by all species of livestock. The goat is often found in degraded environments, because it is the only species able to survive in such conditions. Found at the scene of the crime, it is blamed for it, with little thought given to the complex impacts of different species (including humans) over the preceding 20–30 years. The simplistic thinking which blames the goat does little to solve the underlying problems of environmental mismanagement.

Many of the goat’s characteristics, in fact, mean that it makes little impact on the environment. It is small and light and moves quickly, compared with cattle and sheep. Cattle, grazing hillsides, are likely to cause much more damage through trampling and overuse of paths, which leads to gully erosion. Goats prefer to browse, which tends to even out the pressure on mixed-species vegetation stands. Sheep often pull out grass by their roots when grazing in sandy soils, causing the loss of valuable ground cover and quickly leading to soil erosion. The goat’s natural preference for browse means that they must be controlled, along with other livestock, in areas where young trees have been planted or recently cut forests are regenerating. Young trees can be eaten by hungry cattle and sheep, as well as by goats. The emotive language used against the goat indicates that some appear to believe they can cut down mature trees! People are solely responsible for this, and must take the blame and live with the consequences.

Goats turned loose and left to themselves in a confined, fragile environment (which has occurred on a few small islands) are sometimes too good at surviving and reproducing and may damage the environment in the process. However, this can happen with all species, placed in a similar situation. People must take responsibility for properly managing all their domestic livestock and keeping them in balance with the environment.

1.5 Research and development

Largely as a result of prejudice and ignorance of the importance of goats to farmers in rural areas, there had been little research on goats in developing countries, until about 20 years ago. Scientists in a few developed countries carried out research to support the intensive dairy-goat industries of Europe and North America, but little research was done on goats in developing countries.

Having begun to realise the informal, and normally unquantified, contribution of goats to the rural economy, governments and donors, from the early 1970s onwards, began to fund research and development projects on goats in Africa, Asia, and Latin America. Over the last 20 years a considerable body of knowledge has accumulated on this previously neglected species. There are now regular national, regional, and international research meetings and
information networks on goats. The best known is the 'International Conference on Goats' supported by the International Goat Association, which is held in a different continent every five years.

1.6 The potential role of goats in development programmes

Mahatma Gandhi, the great Indian leader, rightly described the goat as 'the poor man's cow'. But the goat is much more than this. The range of products and services it provides is vast. The goat could justly be called 'the poor person's bank', or 'the poor family's insurance policy'. Goats, of course, can serve rich and poor alike. But many of their characteristics (Table 1.3) lead them to play a special role in alleviating the poverty of the poorest in many developing countries. Goat-development programmes provide an opportunity for development agencies to assist some of the poorest families, in developing countries, through their goats.

Table 1.3 Some advantages and disadvantages of goats

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficient use of fibrous feeds</td>
<td>Susceptible to predators</td>
</tr>
<tr>
<td>Preference for vegetation unused by other species</td>
<td>Small value makes formal credit systems uneconomic</td>
</tr>
<tr>
<td>Efficient use of water</td>
<td>Small value makes formal insurance systems difficult to administer</td>
</tr>
<tr>
<td>Wide climatic adaptation</td>
<td>Susceptible to broncho-pneumonia</td>
</tr>
<tr>
<td>Cheap to purchase</td>
<td>Susceptible to internal parasites</td>
</tr>
<tr>
<td>Spread risks</td>
<td></td>
</tr>
<tr>
<td>Fast reproductive rate quickly builds up flock</td>
<td></td>
</tr>
<tr>
<td>Fast reproductive rate allows early returns from investment</td>
<td></td>
</tr>
<tr>
<td>Small size allows easy and quick movement of household when necessary</td>
<td></td>
</tr>
<tr>
<td>Easy for women and children to handle</td>
<td></td>
</tr>
<tr>
<td>Few facilities required</td>
<td></td>
</tr>
<tr>
<td>Lack of religious taboos against goat meat</td>
<td></td>
</tr>
<tr>
<td>Small size allows easy home slaughter</td>
<td></td>
</tr>
</tbody>
</table>

The philosophy underlying this book is that farmers and pastoralists in developing countries are capable of improving their own lives with very little outside assistance. Many of the suggestions in the book cost little, if anything, to adopt. The emphasis is on making more efficient use of the resources already available, through reducing losses and wastage, and introducing outside inputs to enhance production only when appropriate.
1.7 The aim of this book

There are now many goat-development projects in the developing world supported by governments, bilateral and multilateral agencies, and non-governmental organisations (NGOs). Government and NGO staff are expected to serve in government extension services or on projects without, in most cases, any training, either academic or in-service, specifically on goats. Agricultural colleges in developing countries tend to present sheep and goats together; because most textbooks are about sheep, extrapolations are made, often wrongly, to goats.

This book is written for development workers who do not necessarily have any formal training in livestock production. It explains the theory underlying goat production and how this can be used to design simple improvements. It contains many practical suggestions for how to improve goat production, together with suggestions for how they might be implemented in development programmes. It is written in the belief that technical solutions cannot be divorced from the social, economic, and organisational context into which they are introduced. It is not enough for development workers to know the technology — although they must; they also need to understand the context in which that technology must function. This book attempts to put goat technology in this development context.

Further reading


CHAPTER 2

Common problems of goats in the tropics

2.1 Introduction

Goats are kept in many different systems of production in the tropical world. Different ways of feeding, breeding, and using goats have evolved in response to factors such as the climate, needs of the owner, economic environment, and level of technology available. Within each system of production, goat keepers have developed their own method of looking after goats, according to their own particular circumstances.

If goat-production systems are to be improved, they must be accurately described and their problems properly analysed. This chapter describes the main goat-production systems of Africa, Asia, and South America, classified according to the main agricultural system of which each is part, and the major climate zone in which it is found.

Until about 20 years ago there was very little written information about goats in the tropics, but now there is sufficient research and development experience to be able to predict with reasonable accuracy some of the common problems most likely to occur in the main systems of production. However, most of the difficulties confronted in the field are not simple problems, but are caused by a complex set of factors which all contribute to creating the situation. For example, if many kids die before weaning, which is a problem common to many systems of production, there is rarely any single cause of death that can be simply identified and remedied. Poor nutrition of the dam may cause her to produce little milk, which undernourishes the kid and makes it susceptible to diseases. Although it is a helpful start to know the common problems of the system in which you are working, it is not enough. Each village, district, or region is likely to have its own particular problems, which must be identified before any sensible course of improvement can be followed. Chapter 3 describes how to identify the specific problems of goat production in a village or district. You can make a start by trying to identify the system closest to the one in which you work, using the descriptions below.
2.2 Africa

2.2.1 Pastoral systems: arid and semi-arid

Pastoral systems are found in arid and semi-arid areas of Africa, where low rainfall causes varying degrees of nomadism among the local inhabitants. The system is characterised by a marked seasonality in feed supply; typically there is only one wet season. Annual rainfall may vary from 700 mm to a level as low as 200 mm. Goats may be kept in large flocks, and may, or may not, be mixed with sheep or other species. Goats are kept for meat, milk, and cash, as well as fulfilling various traditional cultural obligations. They are valued for their ability to survive periods of drought better than cattle or sheep. There is likely to be marked variability in production from year to year, because of the highly variable rainfall.

![Figure 2.1 African pastoral system](GEOFF SAYER/OXFAM)

Typical problems found in pastoral goat flocks in Africa:

- high mortality rates in kids before weaning, typically as high as 30 per cent, or higher in periods of drought;
- long parturition intervals, up to two years;
- occasional epidemic diseases, such as contagious caprine pleuropneumonia (CCPP), causing mortality rates of up to 100 per cent.

Factors contributing to problems

There is a marked seasonality in the quantity and quality of forage consumed. During the dry season, low protein levels and high fibre content limit production and may cause weight loss and low milk production. Goats are able to take advantage of a pre-rains...
Common problems of goats in the tropics

flush of growth in browse species which often occurs. There may be occasional mineral deficiencies. Water is scarce, causing infrequent watering and further reducing milk production. Occasional epidemic diseases, particularly contagious caprine pleuropneumonia (CCPP) and peste des petits ruminants (PPR), may have devastating consequences. Internal parasites can be a major cause of kid mortality and loss of milk production. External parasites, particularly ticks, may transmit diseases such as heartwater. Mange can also cause high levels of mortality and morbidity.

There is often a breeding season in pastoralists’ goat flocks. This may be due to green flushes of pasture and browse, triggering oestrus and subsequent mating, or because the pastoralists themselves exercise some control through the use of a leather apron or other device. Having many kids born at the same time can cause kid-management problems, especially if there is a shortage of labour at that time. Kids may require special attention and even bottle feeding. If weak kids do not get this care, they may die. Kids weaned into a long dry season may have problems.

Main opportunities for improvement
Kid mortality can be reduced through better health care, particularly parasite control, and management. Large flocks mean that selection within a breed is possible. Pastoralists could group together to organise group breeding schemes, such as an Open or Closed Nucleus Breeding Scheme, for traits such as growth rate. This could take place within one flock, provided that it is large enough (more than 200). Vaccination against epidemic diseases is recommended where possible.

2.2.2 Agro-pastoral systems: semi-arid
Agro-pastoral systems are found on the margins between areas of cultivation and pastoral areas. The emphasis is on keeping livestock to provide the bulk of the family's food and income. Crops supplement this to some extent. Livestock keepers may grow an opportunistic crop or a regular crop during the wet season and then may move all or part of their stock away during the dry season. The Fulani ethnic group in West Africa are typical agro-pastoralists, but many of them are taking up a more settled existence.

Common problems of goats in agro-pastoral systems:
• high pre-weaning mortality rates;
• occasional epidemic diseases.
Factors contributing to problems

As in pastoral systems, there is a marked seasonal variation in the quality and quantity of feed available. High fibre and low protein levels cause low productivity, particularly in the dry season. This is partly improved by access to crop residues in the dry season. As in pastoral flocks, negative selection for growth may have occurred.

Main opportunities for improvement

Kid mortality should be reduced through better health care, including parasite control, and vaccination of dams. Group breeding schemes to select for fast growth rates would be possible.

2.2.3 Mixed farming: humid

Mixed farming systems in the humid tropics of Africa, for example in Nigeria, Benin, Togo, Ghana, Côte d'Ivoire, and Cameroon, may be divided into those involving cereal and root crops and those predominantly using tree crops. Annual crops may include maize, beans, and rice. Common root crops are cassava, sweet potatoes, yams, and taro. Tree crop systems may include cocoa, oil palm, rubber, plantain, and fruit trees. Goats are normally kept in small numbers, which may range freely and combine with goats from other households to form a village herd scavenging for food. Goats may be tethered or penned during the crop-growing season to prevent crop damage. There is typically a low labour input into this system of goat keeping. Goat breeds in the humid tropics tend to be small but prolific, such as the West African Dwarf goat. In most humid areas of Africa, trypanosomiasis is a problem. Human population pressure is high and increasing in the humid tropics, which is leading to the year-round confinement of goats, and the need to develop cut-and-carry systems of feeding. This will be a continuing trend.
Common problems of goats in the tropics

Common problems in goats kept in the humid tropics:

- high pre-weaning mortality from internal parasites and PPR;
- high adult mortality rates, mainly from PPR (especially in the wet season);
- high morbidity rates from sarcoptic mange, internal parasites, and foot-rot.

Factors contributing to problems

The high moisture content of forage can limit feed intake. Some in-breeding in village herds can occur. Communal herding means that there is little selective mating. Increasing human and livestock populations increase the incidence of disease. Internal parasites are a year-round problem. Seasonally-confined goats are more susceptible to disease and compete for labour during the cropping season.

Main opportunities for improvement

The main opportunities for improvement include vaccination against PPR, drenching, improved housing, and the promotion of cut-and-carry feeding in densely populated areas. Forage development, especially using leucaena and glyricidia fodder trees, may also allow the expansion of flock sizes and extend goat ownership. Improved marketing would also increase the rate of off-take.

2.2.4 Mixed farming: sub-humid

The sub-humid zone lies between the humid and semi-arid zones of West and Central Africa and has rainfall of 1,000–1,500 mm per year. Sorghum and maize are the main crops grown, with
some root crops near the humid zone. The zone may be split into the dry sub-humid, inhabited by pastoralists such as the Fulani, and the wetter sub-humid zone, inhabited by settled farmers. Trypanosomiasis is a problem in the latter zone. Goats may be kept in transhumant (seasonally moved) pastoral flocks which may graze on crop residues in the dry season, returning to grazing lands during the wet season. Some of the pastoralists in these areas may be called agro-pastoralists. Settled farmers keep smaller flocks of goats, which are normally herded with sheep and may be allowed to roam freely during the dry season, but are tethered during the cropping season. They are normally kept in the family compound at night.

Common problems of goats in sub-humid zones:

• high pre-weaning mortality rates;
• adult mortality from PPR near the humid zone.

Factors contributing to problems
Seasonal fluctuations in feed-supply restrict production. Increasing human population is placing a strain on feed resources. Internal parasites are also important in areas of high stock numbers.

Main opportunities for improvement
The development of forage crops can make a major contribution. Vaccination against PPR and drenching for internal parasites are important health interventions.

2.2.5 Mixed farming: highland
Goats are kept in small flocks throughout the highlands of Africa. They may be found as high as 4,000 metres in Ethiopia, where they frequently grow long hair. Typical crops grown on highland farms are maize, wheat, barley, oats, *teff*, and potatoes. Goats may be fed on crop residues as well as grazing on steep hillsides. They may be seasonally tethered, or confined throughout the year in very densely populated areas. Goats are kept for milk, meat, and skins, as well as serving as a source of cash. Their manure provides a small but valuable source of fertiliser for the thin, infertile highland soils.

Common problem syndromes among goats in the highlands of Africa:

• high pre-weaning kid mortality rates;
• poor reproductive performance;
• low milk production.
Common problems of goats in the tropics

Factors contributing to problems

The low intake of poor-quality feed, often crop residues, limits production. Small flock sizes lead to poor conception rates and the possibility of in-breeding. There are several serious disease problems, such as internal parasites (including gastro-intestinal parasites and liver fluke), mange, abortion, and external parasites in lower altitudes.

Opportunities for improvement

The small farm sizes, owing to an increasing human population, encourage the intensification of this production system. This may be achieved through forage development, parasite control and, in some cases, the use of improved breeds.

2.3 Asia

2.3.1 Mixed farming: humid (irrigated)

Arable crop production under irrigated conditions implies that there is a high human population pressure. Rice is the main crop irrigated, with occasional short-season legumes or cash crops, such as sesame. Goats, if kept at all, are normally housed or tethered in some way, and fed with crop residues and by-products. Forage may be cut from rice bunds, or goats may be tethered by roadsides. Countries where this system of production may be found are Indonesia, the Philippines, India, and Malaysia. Goats are kept mainly as a source of cash, but may also be slaughtered at home for special occasions. They may, occasionally, be milked. Goat breeds kept in these systems tend to be prolific. Goats can be an important source of income for landless labourers, who may graze goats on rice bunds or roadside verges.

Common problems of goats in irrigated rice systems:

- high pre-weaning mortality rates (25 per cent);
- low reproductive rates;
- low growth rates.

Factors contributing to problems

Production may be constrained by low feed-intake rates, owing to the high moisture content of cut forage and/or the high fibre content of crop residues. The small flock sizes, when combined with confinement, lead to poor conception rates. Farmers may not always own a buck, and so oestrus detection can be difficult, particularly if the goats are housed. If a buck is owned, in-breeding may occur unless bucks are regularly replaced through purchase, exchange, or loan. The humidity and the presence of irrigation lead to a year-round problem with internal parasites.
Opportunities for improvement

Human population pressure and a strong urban demand for animal products make these systems appropriate for intensification. Feed-intake rates can be improved through selection of palatable forage species, improved trough designs, supplementary feeding, provision of salt, and better water supplies. The design of goat houses can be improved to enable easy oestrus detection. Bucks should be regularly rotated with neighbours’ bucks. Internal parasites can be controlled through drugs, or by wilting forage before feeding. The use of improved breeds may be appropriate.

2.3.2 Mixed farming: humid/sub-humid (rain-fed)

This is perhaps the most common system in which goats are kept in South and South-East Asia. A wide range of systems of production is practised, from full confinement in specially-constructed houses to free grazing on hill sides and crop-stubble fields. Many systems would fall between these extremes. Typically, rain-fed crops would include rice, maize, cassava, yam, taro, sweet potato, and other vegetables. Goats would mainly be kept for sale to generate cash, meat, and manure. Some cultures may milk their goats. Goats in rain-fed mixed farming systems are generally more important to their owners than those of the relatively wealthier farmers living in irrigated systems.

Typical problems of goats in humid rain-fed systems:

- low growth rates;
- low reproduction rates;
- high pre-weaning mortality rates.

Factors contributing to problems

Low rates of feed-intake are due to the high moisture content of forage and high fibre content of crop residues. There are generally low levels of energy in feeds. Small flock sizes mean that breeding males cannot always be kept. If this is combined with confinement, it often leads to poor reproductive performance and in-breeding. Internal parasites are a major problem.

Opportunities for improvement

Human population pressure and a large and expanding urban demand for animal products encourage intensification of this
system, particularly if close to urban market centres and sources of feed supplements. In-take rates can be improved by selection of forage species, improved trough design, feeding of energy supplements, and provision of salt and water. Forage development is an important option. Conception rates can be improved through better oestrus detection (by allowing bucks better access to does), or through more alert management. Rotating bucks with neighbours' bucks reduces in-breeding. Internal parasites can be controlled by use of anthelmintics or by wilting forage before feeding. The use of improved breeds could be considered.

2.3.3 Extensive systems: semi-arid (high altitude)
Extensive goat-raising systems are found in the arid and semi-arid areas of Pakistan, India, Bangladesh, and Nepal. Nomadism is practised to varying degrees. Flock movement tends to follow a transhumant pattern, with goats grazed at higher altitudes during spring and summer returning to lower altitudes during autumn and winter. Flocks may graze crop-stubble fields at the lower altitudes during the winter. Kidding is seasonal, taking place mainly in the spring. Kids are fattened on the high-altitude summer pastures. Does are normally milked, and male kids fattened for sale. Cashmere-fibre production and processing is often an important by-product. The coarse hair may be used for making rugs and rope.

Common problems of goats in extensive grazing systems:
• high pre-weaning mortality rates;
• slow growth rates.

Factors contributing to problems
Seasonal fluctuations in quality and quantity of grazing, combined with a general decline in available grazing areas, are a major source of problems. A shortage of labour may lead to problems in kid management during the peak kidding season.

Opportunities for improvement
Higher off-take is probably the most important intervention. Improving marketing and possibly encouraging the development of specialised fattening systems at lower altitudes would be useful. There are few nutritional interventions which do not involve lowland cultivators in some provision of better winter feed. Appropriate vaccination should be encouraged.
2.4 Central and South America

2.4.1 Extensive systems: semi-arid

Goats are kept in extensive grazing systems throughout the semi-arid areas of Central and South America. Small flocks of 2-10 goats may be allowed to graze freely, often with other species. These small flocks are often owned by agricultural labourers working on large estates or cattle ranches. Larger flocks of 20-50 may be herded by family or hired labour. They are mainly kept for meat and skins, which may constitute up to 30 per cent of the value of the goat. In many cultures kids, 2-6 weeks old, are consumed as a delicacy. There is a trend towards the greater home consumption of goat milk and dairy products in many countries. Grazing is a mixture of grass, herbaceous plants, and trees, known as caatinga in Brazil, which is often vegetation regenerating after deforestation of the area for ranching or cash-crop production. Goats have proved to be relatively drought-tolerant and are the last species sold during severe droughts.

Common problems among goats in extensive systems:

- high pre-weaning kid mortality;
- poor-quality skins;
- low milk production.

Figure 2.5 A mixed flock of sheep and goats in Bolivia

SEAN SPRAGUE/OXFAM

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Factors contributing to problems
Seasonal fluctuation in feed supply restricts milk production and increases kid mortality. Skins are often damaged through poor flaying and preservation methods.

Main opportunities for improvement
Supplementary feeding of lactating does, improved health care, and better skin processing are some possibilities. The increasing interest, among both rural and urban populations, in goat milk and dairy products might lead to the further intensification of goat production and the possibility of breed improvement.

2.4.2 Mixed farming: sub-humid
Goats are often kept tethered or housed in more intensive systems in the sub-humid zones of Central America, including the West Indies, and northern margins of South America. Goats form part of a more intensive mixed farming system. Natural vegetation, including a wide variety of tree leaves, such as *Erythrina* spp, makes up most of the diet, which may be cut and carried to housed goats. This diet may be supplemented by tree legumes, such as glyricidia, as well as cultivated grasses such as *Panicum* spp, and crop by-products such as banana stems, and other fruit and arable crop by-products. The main products are meat, including kid meat, skins, and cheese. Goats are a significant source of cash income, as well as being an important form of savings.

The main problems of goats in intensive systems are listed below:

• high pre-weaning mortality rates among kids;
• low milk production;
• some evidence for high abortion rates;
• respiratory problems in some housed goats.

Factors contributing to the problems
There are fluctuations in the quality and quantity of the diet, and internal parasite problems. The main causes of abortion are thought to be poor nutrition and brucellosis.

Main opportunities for improvement
There is great potential for the intensification of this system through forage development to reduce the seasonal fluctuations in feed supply, through improved health care, and through the use of improved breeds.
2.5 Minor systems

2.5.1 Perennial tree-crop systems

Goats in many of the humid and sub-humid parts of Asia, the Pacific Islands, and to a lesser extent in Africa may be grazed underneath perennial tree crops such as cocoa, coconuts, oil palm, and rubber. There are two main systems of production. Large flocks may be kept by estate owners, primarily to keep down the vegetation under the trees and so improve tree growth and facilitate harvesting. Shade-tolerant legumes may be grown to protect the soil and to provide high-quality fodder to the goats. Tree crops such as oil palm and rubber also produce effluent from processing factories which can be used to fertilise improved pastures for goats or other ruminants. Tree-crop processing may also provide by-products which can be used as feed supplements, for example palm-kernel cake and palm-oil sludge. In rubber-tree plantations there is a risk of goats disturbing the latex-collection cups. Goats may also be kept by landless estate workers as a valuable source of cash. A small herd may be tethered in the estate or beside estate roads.

2.5.2 Urban goat-keeping

The sight of goats scavenging in urban areas in tropical countries is relatively common. Being of such an independent character, goats easily adapt to looking after themselves in what would appear to be an alien environment. Goats may also be kept...
confined in backyards, and feed collected or even purchased for them. Their relatively small feed requirements make them more convenient than cattle in providing members of the urban population with a source of milk, meat, and cash. The problems of urban goat-keeping are finding sufficient feed and, in scavenging goats, digestive disturbance from the consumption of plastic bags!

2.6 Which system is closest to the one in which you work?

Think about the goat-keeping system in which you work. Which of the systems described above is closest to the one you know? What characteristics made you decide? What differences are there between your system and the one described that you think is closest to it?

Further reading

CHAPTER 3

Assessing goat-production problems

3.1 Introduction

The start of any development initiative is the time to ask fundamental questions about the situation to be improved, and about what is an improvement. Often what is thought to be an improvement by outside 'developers' is very different from farmers' own ideas. Farmers have many reasons for keeping goats, and unless these are understood it is impossible to develop appropriate improvements. For example, scientists commonly suggest methods of improving the growth rates of goats. This is appropriate when farmers are trying to maximise their cash profit and where the costs of inputs are carefully related to the levels of output. However, most farmers and pastoralists in the tropics have many different objectives in keeping goats, and trying to avoid losses and reduce risks may be more important than maximising profits. Before any practical steps are taken, the existing situation must be assessed, and the farmers concerned must be consulted. Unless they actively participate in evaluating their existing situation, defining their problems, and expressing their aspirations, the development initiative is doomed to fail.

The objective of this chapter is to give the reader the tools to be able to identify the specific problems of goat production in a village, district, or region, in order to develop, with farmers and pastoralists, the means of improving goat production.

3.1.1 Methods to identify specific problems of goat production

The common problems of goat production in different systems in the tropics have been described in Chapter 2, which may be used as a starting point in identifying the likely problems of goat-keeping in an area. The next step is to investigate the particular problems of a specific area, district, or village in order to identify the
purposes of the farmers in keeping their goats, and to identify their problems and opportunities for improvement.

Many methods have been developed by agricultural scientists for evaluating farming situations, identifying problems found in the system, and developing solutions. The methods range from the quicker methods such as Rapid Rural Appraisal (RRA) or Participatory Rural Appraisal (PRA) techniques to more complicated Farming Systems Research (FSR) methods requiring the collection of a great deal of information about the agriculture of an area. These methods can broadly be divided into those that require only a few visits to an area and those that require the long-term monitoring of the situation in question.

Two procedures will be described in this chapter. The first is for the extension/development worker working in a remote area, possibly alone or with a small group of people. It is envisaged that this worker has little assistance from outside and would not have access to facilities such as laboratories to carry out feed analyses or disease investigations. What low-cost methods can be used by such a person with little or no external support, to identify problems of goat production?

The second approach to problem identification is for an individual, or more likely for a team, engaged in a goat project or programme, possibly with external donor funding, or at least with government support. It is imagined that this person or team would have access to specialists, laboratories, libraries, and perhaps computers, to assist in a detailed analysis of the problems. What can be done with this higher level of external support?

The steps followed and techniques used in each approach are outlined in Table 3.1.

### 3.2 Low-cost methods of assessing goat-production problems

It is assumed that a development worker wants to help a village or district with goat production and that in this case goats are already kept by at least some members of the community. The questions to ask when considering the introduction of goats into communities that have not previously kept them will be discussed in Chapter 11.

The methods of assessment discussed below are methods that focus specifically on goats and the people who keep them, and the physical and social contexts in which they are kept. The methods described require nothing more than a pencil and paper, although access to a photocopier or stencil machine would save time. Many development workers feel unable to initiate development activities
Low-cost methods of assessing goat-production problems

Table 3.1 Procedures to identify problems of goat production

<table>
<thead>
<tr>
<th>Low-cost methods</th>
<th>Higher-cost methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual at village/district level</td>
<td>Project planning team</td>
</tr>
<tr>
<td><strong>Define objectives</strong></td>
<td><strong>Define objectives</strong></td>
</tr>
<tr>
<td>Secondary information</td>
<td>Secondary information</td>
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<tr>
<td><strong>RRA Techniques</strong></td>
<td><strong>RRA Techniques</strong></td>
</tr>
<tr>
<td>Public meeting</td>
<td>Public meeting</td>
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<tr>
<td>Group discussion</td>
<td>Group discussion</td>
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<tr>
<td>Feed calendars</td>
<td>Feed calendars</td>
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<tr>
<td>Disease calendars</td>
<td>Disease calendars</td>
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<tr>
<td>Problem ranking</td>
<td>Problem ranking</td>
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<tr>
<td><strong>Individual interviews</strong></td>
<td><strong>Individual interviews</strong></td>
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<td>Flock structure</td>
<td>Interview</td>
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<td>Progeny histories</td>
<td>Direct observation</td>
</tr>
<tr>
<td>Interview</td>
<td>Expert interview</td>
</tr>
<tr>
<td>Direct observation</td>
<td>Maps and walks</td>
</tr>
<tr>
<td>Expert interview</td>
<td>Community consultation</td>
</tr>
<tr>
<td><strong>Maps and walks</strong></td>
<td><strong>Maps and walks</strong></td>
</tr>
<tr>
<td>Community consultation</td>
<td>Community consultation</td>
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</tbody>
</table>

**Monitoring** (minimum 1–2 years)

Select sample
Initial flock inventory, including flock structures, progeny histories and weight
Ear-tag all goats, start regular recording of:
- productivity
- disease
- feed
- management
- marketing

**On-farm trials of improvements**

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Outputs</th>
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<tbody>
<tr>
<td>Some specific problems of goats identified.</td>
<td>Detailed problems of farmers and goats identified, including seasonal dynamics of problems.</td>
</tr>
<tr>
<td>Farmers’ needs and aspirations identified.</td>
<td>What constitutes an improvement?</td>
</tr>
<tr>
<td>What constitutes an improvement?</td>
<td>How can it be achieved?</td>
</tr>
<tr>
<td>How can it be achieved?</td>
<td>How can it be achieved?</td>
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</tbody>
</table>
Assessing goat-production problems

without some sort of external help from a donor agency. This need not be so. There are many improvements to goat production that do not require anything to come from the outside and can be achieved with simple practical modifications to the existing system. See what you can do in your area.

3.2.1 Secondary information

Start by finding out what is already known about the area in which you work. Secondary information is information on an area or topic that may already exist in government reports, research papers, newspaper articles, and maps. Often this information is hard to obtain, and in a remote area may be impossible. However, it is important to try to find out what information is already known about the area in which you are working, so that you do not waste time collecting it again.

3.2.2 Public meetings

The involvement and active participation of goat keepers themselves in identifying their own problems is the key to obtaining an accurate picture of the current situation and developing solutions that farmers truly want.

At the start of any information-gathering exercise, it is usually a good idea to hold a public meeting, involving the whole village or community, at which the objectives of collecting the information are clearly explained. This provides an early opportunity to build up trust, as the community is able to question your credentials. Explain the sort of cooperation you need. Choose a time and place that is convenient for the farmers and not just for you, perhaps on a holiday or at night after work, or in a less busy season.

Start by introducing yourself, and then clearly explain the objectives of collecting the information. If you come from a government organisation, explain how the information will be used. Be honest about your resources and the limitations on your ability to assist the community. It is important at the first meeting that you are open to questions. In some societies farmers are not used to questioning outsiders at public meetings, particularly if they come from the government; but they should be encouraged to do so, to reduce suspicions. Make it clear that you have come to learn and help them to solve their problems, and improve the benefits that they get from their goats. Make it clear that you do not have all the answers to their problems, but that together with them you will try to help them as best you can and with the resources at your disposal. Don't make empty promises.

Explain the timetable of the data collection and whether you would like to talk to people individually or in groups. This is also a
good moment to let those attending the meeting identify individuals who are recognised experts, whom you can question later on.

In some cultures it is not possible to have meetings where men and women can sit together and where women feel comfortable speaking in public. If this is the case, try to organise a separate meeting for women in a situation when and where they feel comfortable to question you and freely respond to your questions.

Many approaches can be taken after the initial meeting. You and your team can start talking to individuals, groups, or experts. This may be in the week or two following the original meeting, or during a couple of days a week for the following few weeks. Make a programme for data collection that is convenient for the community.

3.2.3 Approaching interviews and discussions

There are many ways of carrying out interviews and discussions in rural communities. They range from the formal questionnaire survey of individual households to unstructured group discussions. Each method has certain advantages and disadvantages; the choice depends on the purpose of the interview and the sort of information you hope to obtain from the community.

The most important precondition for any discussion, whether with an individual or group, is that there is some degree of trust between those asking questions and those answering. It is always better if the interview can take the form of a dialogue rather than a long list of questions. The quality of the information received will be immeasurably better if the goat keepers have confidence in those asking the questions. This may be hard to achieve, if you are coming to a new area where you are not known. In this case, try to obtain the help of a local extension person from the area, who is already well known and respected by the community.

It is important that the purpose of the interview or discussion is clearly explained, so there is no misunderstanding. If you are an outsider arriving for the first time, people may have expectations of assistance associated with you. Be aware of this and never make promises you cannot keep, or your credibility will be lost.

3.2.4 Group discussions

Discussions held with groups of goat farmers, for one or two hours, can be a very useful method of obtaining qualitative information very quickly. A range of opinions can be obtained from the different members of the group and a consensus can be reached about what normally happens in that particular area. Listen to the way farmers discuss issues and argue about them among themselves. A group discussion is also a useful forum to cross-check with the group any queries that may arise from other group discussions or individual interviews.
Assessing goat-production problems

The main disadvantage of a group discussion is that normally the information is exclusively qualitative. It is hard for the group to calculate mortality rates over the last year, for example, whereas this is relatively easy for an individual farmer to estimate for his or her own flock. The group may give you an estimate of how many goats in the village died from a recent epidemic, but this is only an estimate and is likely to be exaggerated. You should treat such group estimates as a figure used to show you the severity of the epidemic.

The group discussion should be organised according to the principles for the public meeting. The farmers should be comfortable and undistracted. The meeting should be organised at a convenient time and place and should not last too long. The size of the group should be such that everyone in it has a good chance of contributing to the discussion. If it is too small, you won't get the breadth of experience that you are seeking. Probably a group of five–ten is ideal. Do not allow one or two individuals to dominate the meeting.

It is not always possible to select the knowledgeable farmers to join the group, but you should try to choose the people who are likely to have the knowledge you need. Women are often responsible for looking after goats, so they must be involved in group discussions, either with the men or separately. It is often revealing to discuss the same issues with women that were discussed with the men, to obtain their different perspectives on the issue.

Do not rely on the results from one discussion. Several group discussions should be held, often covering the same issues. In this way a more accurate picture of problems can be built up and investigation begun of the factors contributing to these problems.

What information is best collected from a group discussion? Such a meeting can give a quick picture of goat production in the area, which is a useful start to further investigations. Specifically, it should enable you to do the following:

- compile feed calendars
- compile disease calendars
- rank problems
- identify improvements
- identify farmers' aspirations.

3.2.5 Feed calendars

In most systems of production in the tropics, the supply of feed to goats varies according to the season. This is the case whether the goats are grazing or feed is cut and carried to them. The main sources of feed (hillside grazing, swamp grazing, crop residues, feed supplements, etc.) and the methods of feeding them
Low-cost methods of assessing goat-production problems

(herding, tethering, housing, etc.) are likely to vary through the year, and it is crucial to understand this variation.

If you are working in a different culture from your own, first name the months of the year according to the local names. Then group them into seasons. Sometimes it is easier for farmers to think about a specific year, say last year, and talk about that. However, if you do use a specific year, be careful. If a season didn’t come (the rains failed), then farmers might miss out that season altogether, because it didn’t happen! Next, go through each season and ask what is fed to goats in that season and how it is fed. You can further refine this technique by asking about the quantity of feed in each season and the times when there are particular problems in finding enough feed. You may draw a line on the ground to represent the year and get farmers to put leaves or stones on the months when there is a lot of feed.

If you are in a mixed farming system, it is important to understand the links between the cropping system and the goat system. Try to get a picture of the cropping system and link feed supply to the seasonal cropping pattern. The method of feeding should also be linked to the labour demands for crop production, in order to identify the busiest times of the year, and when goats are most likely to compete with crop production for labour. It is important to identify which members of the family are responsible for the various tasks involved in goat-keeping. Seasonal calendars can be constructed for each task, indicating the age and sex of the person involved during each season. Remember that farmers may keep other livestock which compete with goats for feed.

Figure 3.1 shows an example of a seasonal feed calendar for a mixed farming system.

3.2.6 Disease calendars

The seasonal pattern of disease incidence can be described in a similar way as for feed. First identify the common diseases of goats. Farmers will use their own local names, so ask them to describe the symptoms clearly, so that you are able to make a reasonable identification of the disease. Ask which sorts of goat are affected (kids, adults, males or females) and then ask when each disease is most prevalent. It may occur all the year round or only in the wet season. Ask the farmers to describe the effects of the disease (such as sick but recovers, immediate death, etc.), so that at the end of the session you are able to identify the most important diseases and when they occur. If farmers keep other livestock, it may also be important to describe their diseases, as there may be transmission of diseases between species. An example of a disease calendar is given in Figure 3.2.
Assessing goat-production problems

Figure 3.1 A seasonal feed calendar
3.2.7 Problem ranking and identification of improvements

The group discussion is an excellent forum to ask about the major problems of goat-keeping and to hear what farmers think would be an improvement. You need to take great care to focus the group on issues that you and they can actually solve together. If you ask any group of farmers what their problems are, they are likely to list many things that are indeed problems, such as low goat prices or lack of water, but which cannot be solved without a lot of money or by a change in government policy. Explain again who you are and what sorts of things you and your organisation are able to help the community with. Talk through the problems that farmers have identified, and begin to work towards identifying problems that can, realistically, be solved by the farmers themselves. Table 3.2 sets out a simple format that might be used with a group to specify more fully a problem identified in the discussion.

Get the group to list their problems and reach a consensus, by vote perhaps, on which is the most important problem, the second most important problem, and so on. Try to include a wide range of...
Table 3.2 Guide to problem specification

<table>
<thead>
<tr>
<th>Questions</th>
<th>Problem 1</th>
<th>Problem 2</th>
<th>Problem 3</th>
</tr>
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<tbody>
<tr>
<td><strong>What</strong> is the problem?</td>
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<tr>
<td><strong>Where</strong> is it a problem?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>When</strong> is it a problem?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Who</strong> has this problem?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What evidence is available?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional evidence required?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class of problem?</td>
<td></td>
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</tr>
</tbody>
</table>

views here. Men may easily say that their goats don’t produce enough kids because they are not fed well enough, but the women who cut and carry the feed to the goats may say that their problem is the amount of time it takes to collect the feed, taking them away from other important tasks. These are both feeding problems which could be overcome by the introduction of improved forages. When different viewpoints emerge in response to the same problem, it is sometimes helpful to draw a simple diagram setting out the causes of the problem and linking them together into a network of factors affecting the problem of concern (Figure 3.3). These chains can be developed for several different problems; it may emerge later that several problems share a common cause, and these chains can be linked together to make a larger problem tree. This will be discussed below in 3.2.13.

What constitutes an improvement in any situation is largely influenced by the purpose for which goats are kept, and any improvement programme is doomed to fail if the proposed improvements are not in keeping with the purposes of the goat owners. Goats may be kept for manure production, or merely to have a goat for sale in times of trouble. Farmers may be more concerned with reducing risk than with increasing production, if that will increase the risks. It is of fundamental importance that you clearly understand the reasons for which goats are kept, so that you are able to help farmers achieve their objectives better. This is not to exclude the possibility that farmers may not change their objectives over time. It is often found in goat-improvement programmes that, in order to gain the interest of farmers, programmes should be designed to meet traditional objectives, but that, once farmers start to learn about new technologies, their objectives may change to take advantage of the new technology.
3.2.8 Rapid flock-appraisal method

The information obtained in group discussion tends to be of a rather general nature, so it is important to obtain more specific information about individual flocks, their performance and management. A surprising amount can be learned from one visit to a family and their goats. Through a simple field technique it is possible to find out the flock size, flock structure, the reproductive performance of breeding females, and the fate of their offspring. The owner and the owner’s family can be interviewed to find out their individual management practices and the problems they face in keeping goats.

**Flock size**

Knowing the sizes of the flocks in an area helps one to understand

- the relative economic importance of goats (if the importance of other farm enterprises is known);
- the labour required to look after the goats.

When a flock’s age and sex composition (known as the flock structure) is determined, it can provide a picture of the flock at one point in time. This is the most basic information about the flock. But flocks are dynamic: goats are born, sold, given away, consumed, bought, borrowed, and lent. So any flock structure represents a snapshot of the flock — the past events — as well as the future intentions of the owner. It represents:
Assessing goat-production problems

- the past events in the flock (the birth and death rates, as well as levels of off-take);
- the owner’s objectives in keeping the flock (whether the purpose is meat or milk or both).

It is very easy to combine a rapid study of flock structures with collecting information on the reproductive performance of breeding females and the fate of their offspring.

**Sample size and selection**

It is usually impossible to visit every goat keeper in the village or district. A smaller group or sample of households has to be selected, representing as closely as possible the characteristics of the population of interest. The use of statistical sampling procedures will indicate, for a measurement, the size of sample that will accurately represent the whole population from which it is selected. These procedures cannot be applied unless the size of the population is known, together with the degree of variability within the selected village or district. In practice, of course, in developing countries, very little information of this nature exists. In some countries where censuses are carried out, a list of households in the village may be available and can be used to select a sample. But in order to use statistical sampling procedures, the amount of variability and the precision of information required should also be known; this, however, is rarely possible.

In reality, practical considerations become more important than considerations of statistics. Common questions to answer are listed below:

- How much money is available to collect the data?
- How many people can be employed or released from other work to carry out the assessment?
- How much time is available?
- Are there vehicles available?
- Is there enough stationery?

Once these questions have been answered, the next question is: with the resources available, how many goats/households/villages/districts can be covered in the time available? The basic rule is that the more households the better: the bigger the sample, the more precise will be the results.

When you have decided how big a sample you can afford with the resources you have available, you need to think what sorts of goat keeper should be in the sample. Do you want to get a representative picture of the total population, or do you want to focus only on particular types of goat farmer, such as the poorer ones, or only those with larger flocks, or only goat farmers who house their goats?
If the sample is supposed to give a picture of all goat farmers in the area, it is important to try to avoid many of the biases that can creep in and distort the picture. If you are new to the village, the first people you will meet will probably be the village leaders, who will want you to meet the best, most progressive goat farmers in the community — who are probably some of the wealthiest. You may then have to make a special effort to meet the poorer farmers. Perhaps you can go to the communal watering point and chat to people there and observe the goats as they come to water. If you are in a hurry, beware the temptation to visit only the most accessible farms, close to the road. This is especially likely in the wet season, when the roads may be bad or even impassable. A number of small biases, when combined, can give a very distorted picture of reality. Unless you make a special effort, you will find yourself dealing primarily with men rather than women, and confident people rather than shy ones. This is why the group discussion is particularly useful in providing cross-checks within the community, to give a clearer, more balanced picture.

**Field method**

1. Prepare a data-collection form which is easy to fill in quickly. Test the form while collecting information on a few flocks. An example is found in Figure 3.4. You may like to adapt it for use in your own area. Prepare enough forms for the anticipated number of goats and flocks. It is irritating to run out of forms when you are in a remote area.

   At least two people are required for the job, one to handle the goats, the other to record the information on the form. In larger flocks it is more efficient to have more than one person handling the goats, as the recorder can note down information from at least two goat handlers and possibly more. The quicker the data are collected the better, so the owner is less inconvenienced.

2. The owner of the flock should be politely approached and the objectives of looking at the flock should be clearly explained. Most owners are happy to allow their animals to be handled, provided they are handled gently, and the owner is not inconvenienced too much in the process. However, in some areas taxes on livestock are collected, which may make the owner reluctant to allow the flock to be visited and counted, and may also lead the owner to give misleading information concerning progeny histories. Clearly explain the purpose for collecting the information and give assurances that it will be kept confidential.

3. Agree a time and place that is convenient for the owner and the owner’s family. If the flock goes out grazing all day, you may
Assessing goat-production problems

**Figure 3.4** Form for recording goat flock structures and progeny histories

<table>
<thead>
<tr>
<th>Date</th>
<th>Recorder</th>
<th>District</th>
<th>Village</th>
<th>Owner's name</th>
<th>Remarks (milked, sick, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<thead>
<tr>
<th></th>
<th>Aborted</th>
<th>Lost</th>
<th>Exchange</th>
<th>Gift</th>
<th>Lent</th>
<th>Sold</th>
<th>Dead</th>
</tr>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tooth age:</th>
<th>MT suckling</th>
<th>MT weaned</th>
<th>1 pair</th>
<th>2 pairs</th>
<th>3 pairs</th>
<th>4 pairs</th>
<th>Worn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>male</td>
<td>female</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>castrate</td>
<td></td>
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</tbody>
</table>

**MT = milk teeth**
Low-cost methods of assessing goat-production problems

have to visit very early in the morning or in the evening, when the animals return from grazing. If the flock has to walk a long way to grazing, they may leave and return in the dark, in which case torches will be needed. Alternatively, it may be more convenient to handle the flock at a water point or dip, where they may be in one place for several hours.

4 Each goat in the flock should be physically handled and a record made of its sex (male, female, castrate, hermaphrodite) and age by dentition (suckling, milk teeth, one pair, two pairs, three pairs, four pairs, worn) recorded. The owner is then asked its age and origin (born in flock, bought, borrowed, given). In some societies goats may be owned by different members of the family, who might have different rights of use over their goats. This may be important to record. If the goat is kept under some sort of sharing arrangement with another family, the arrangements should be understood. For females of breeding age, you should record the number of times they have given birth, and what has happened to each animal born:

- still in flock
- sold
- dead (cause)
- lent
- given away
- aborted
- exchanged
- lost

It is also useful to ask the owner the cause of death, and even the season in which the goat died. This can be very helpful in building up a picture of the seasonality of the causes of mortality, which can be very important; but collecting this extra information will slow down the procedure.

As goats are often tended by women or children, you will often get more accurate information if you ask them the questions, particularly about deaths and abortions. However, in some cultures male extension workers may not be allowed to talk directly to women. You need to exercise sensitivity in such a case.

The goat should then be marked in some way, such as with a special waxed marker crayon or simply a water-based paint, to ensure that it is not handled again. Or it should be removed from the pen and kept with the goats that have already been handled.

How to age goats by their dentition

Goats are born with small milk teeth, which they will keep until they are 14–19 months old, when one pair of permanent incisors will replace the central pair of milk teeth. Thereafter further pairs of these permanent teeth appear either side of the previous new teeth, roughly every six months, until they have a full set of four permanent pairs of incisors (Table 3.3 and Figure 3.5). Teeth do
not appear at fixed intervals. There will always be a range of ages at which particular teeth appear, because the speed of teeth-growth will vary according to the health and nutrition of the goat. If a goat is well fed and healthy, teeth will erupt earlier than in poorly fed, unhealthy goats. Likewise, teeth age and become worn at different rates in different systems. In extensive pastoral systems where the forage may be very fibrous for long periods, teeth will wear faster than in the humid tropics, where feed is lower in fibre.

Although it is not possible to identify the exact age of a goat from its teeth, it is a useful guide which can be used, to some extent, to evaluate the performance of goats. If, for example, you want to know how well a female goat is breeding, you can check its age from its teeth and if you see, say, three pairs of permanent teeth, you know that the goat is roughly two and a half years old. You can then ask the farmer how many kids it has had in its lifetime. If it has had two kids, then you know that it is fertile and a good breeder. If it has had one or none, then you should be aware that there is a reproductive problem which probably should be investigated.

### Table 3.3 The age of goats as shown by dentition

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Type of teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 14</td>
<td>Milk teeth</td>
</tr>
<tr>
<td>14 - 19</td>
<td>One pair of permanent incisors</td>
</tr>
<tr>
<td>19 - 24</td>
<td>Two pairs of permanent incisors</td>
</tr>
<tr>
<td>24 - 30</td>
<td>Three pairs of permanent incisors</td>
</tr>
<tr>
<td>30+</td>
<td>Four pairs of permanent incisors</td>
</tr>
</tbody>
</table>

### How to interpret the data

The data can be analysed using a pencil and paper. A simple pocket calculator is helpful, but not essential. Do some analyses while still in the field, so that any queries can be checked immediately.

1. First calculate the average size of goat flocks in the area investigated, and the range in sizes. It is sometimes helpful to make a bar chart of this information, so that the degree of variability in the size of the flock is very clear (Figure 3.6).

2. Next, using all the data collected, make a table of the flock structure for all goats sampled. The table might be presented in the form of Table 3.4. What can be learned from such a
table? If there are a lot of very young suckling kids with their lactating mothers, it may be that there is a seasonality to the breeding of the goats. Reckoning backwards, it is possible to calculate the peak season of conception. This seasonality in breeding may be controlled by the owner, or it may occur naturally because a flush of good feed initiates oestrus and conception. Find out which applies by asking the owner.

If there are a lot of goats being milked but few kids suckling, then it looks as though significant numbers of kids have died recently, and it would be worth trying to find out why. This is usually fairly obvious while the flock is being recorded, so the owner can immediately be asked what happened to the kids.

The ratio of breeding females to males can be calculated to make sure that there are enough breeding males. If certain males are castrated (this varies from culture to culture), it would be worth finding out the age at which they are castrated and the reasons for castrating those particular males. Is it because they were fast-growing and needed for sale, or because they were slow-growing and the owner did not want them to mate with the females?
Table 3.4 Sex and age structure of Maasai goats in Kenya (expressed as a percentage of the total)

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Entire males</th>
<th>Castrated males</th>
<th>Total males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 6</td>
<td>4.5</td>
<td>0.0</td>
<td>4.5</td>
<td>7.2</td>
<td>11.7</td>
</tr>
<tr>
<td>6 - 14</td>
<td>2.9</td>
<td>2.3</td>
<td>5.2</td>
<td>5.2</td>
<td>10.4</td>
</tr>
<tr>
<td>14 - 19</td>
<td>1.0</td>
<td>7.4</td>
<td>8.4</td>
<td>9.4</td>
<td>17.8</td>
</tr>
<tr>
<td>19 - 24</td>
<td>0.1</td>
<td>1.5</td>
<td>1.6</td>
<td>4.5</td>
<td>6.1</td>
</tr>
<tr>
<td>24 - 30</td>
<td>0.05</td>
<td>4.3</td>
<td>4.3</td>
<td>6.7</td>
<td>11.0</td>
</tr>
<tr>
<td>30 - 60</td>
<td>0.4</td>
<td>9.3</td>
<td>9.7</td>
<td>32.9</td>
<td>42.6</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Total</td>
<td>8.9</td>
<td>24.8</td>
<td>33.7</td>
<td>66.3</td>
<td>100</td>
</tr>
<tr>
<td>n =</td>
<td>122</td>
<td>335</td>
<td>457</td>
<td>899</td>
<td>1356</td>
</tr>
</tbody>
</table>

Figure 3.7 Age pyramid of a goat flock
If there is a missing kid crop, i.e. a very low or non-existent number of goats between the ages of for example 14 and 24 months, then it might indicate a drought or disease that affected the young kids between one and two years ago. The effects can still be seen in the flock. What caused this?

3 A simple age pyramid (Figure 3.7) may also be revealing. It may show any missing kid crops, the age at which most males are sold, etc.

4 From the information on progeny histories, it is possible to calculate the number of births per breeding female, and the approximate age at first parturition. Set out the table headings shown in Table 3.5. Place each breeding female in the correct age group and write down the number of times she has given birth, as reported by the owner. Add up the totals for each age group category as in Table 3.5, and a total for each birth number category. Finally convert these totals to percentages, as in Table 3.5.

### Table 3.5 Parturition histories

<table>
<thead>
<tr>
<th>Age group of female (months)</th>
<th>Number of births reported by owner</th>
<th>No. of females</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-14</td>
<td>0 1 2 3 4 5 6 7 8</td>
<td>36</td>
</tr>
<tr>
<td>14-19</td>
<td>109 5</td>
<td>114</td>
</tr>
<tr>
<td>19-24</td>
<td>37 14 7</td>
<td>58</td>
</tr>
<tr>
<td>24-30</td>
<td>45 38 6</td>
<td>89</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>35 87 135 73 52 17 12 6 2</td>
<td>420</td>
</tr>
<tr>
<td>Total</td>
<td>262 144 148 73 52 17 12 6 2</td>
<td>717</td>
</tr>
<tr>
<td>%</td>
<td>36 20 21 10 7 2 0.8 0.3</td>
<td>100</td>
</tr>
</tbody>
</table>

From this table it is clear that there are reproductive problems in the goat flocks in this area. Having 36 per cent of the potential breeding females non-productive is a tremendous waste. If they have not given birth by 24 months of age, either they are infertile or there is a major mating/nutrition problem, which should be investigated. Age at first parturition also seems to be rather delayed, which reduces the total productive life of the goat.

5 It is also possible to make a rough estimate of an annual reproductive rate. This can be done by assuming that the ratio of
Assessing goat-production problems

males to females is 1:1. Then multiply by 4 the number of females in the age class 0–6 months, to arrive at the total number of births in a year, excluding deaths. Apply a reasonable mortality rate by deducting 10–20 per cent from this figure. Now divide the result by the number of potential breeding females (those that have reached 12 months). From Table 3.4 the annual reproductive rate is 66.6 per cent, which is very low.

\[
\text{Approximate annual reproductive rate} = \frac{4 \times \text{Total 0-6 mths} \times 100 - \text{Mortality (\%)} }{\text{Total potential breeding females}}
\]

Finally a table showing the methods of off-take from the flock can be prepared, such as Table 3.6.

<table>
<thead>
<tr>
<th>Method</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remain in flock</td>
<td>51</td>
</tr>
<tr>
<td>Dead</td>
<td>36</td>
</tr>
<tr>
<td>Sold</td>
<td>7</td>
</tr>
<tr>
<td>Abortion</td>
<td>4</td>
</tr>
<tr>
<td>Gift</td>
<td>2</td>
</tr>
<tr>
<td>Lost</td>
<td>0</td>
</tr>
<tr>
<td>Slaughtered</td>
<td>0</td>
</tr>
<tr>
<td>Exchanged</td>
<td>0</td>
</tr>
</tbody>
</table>

3.2.9 Individual interviews

If the owner has the time, and is willing, a good moment for an interview is after you have examined the flock for the structure and progeny-history data, and it is obvious that you have a genuine interest in the goats. This can form a bond between you. Otherwise make another appointment at the owner’s convenience.

Unless it is just a casual visit to a family for a chat about their goats, it is best to have at least a checklist of questions you would like to ask them. If you lack confidence in talking to farmers, or need more quantitative survey data, then use a questionnaire. You can train recorders to administer the questionnaire on your behalf, so enabling you to question many more farmers than you can by yourself. If you do use inexperienced recorders to do a survey, keep the questions simple, so that accuracy is maintained. You cannot expect these recorders to ask probing follow-up questions. Keep the questionnaire simple and short. Long questionnaires are boring for all involved. Avoid sensitive matters, such as direct questions about income. The accuracy of the information will not be very high if the farmer is bored, embarrassed, or suspicious about the questions.

For more information on survey and questionnaire design, see Social Survey Methods and Choosing Research Methods, both published by Oxfam (UK and Ireland).

3.2.10 Key informant interviews

There are often farmers in a community who are recognised experts in keeping goats or in some particular aspect of goat
husbandry such as treatment of diseases. These people can provide a wealth of information on different aspects of goat production in the area, the long-term trends, and a perspective on the degree of variation between years. When was there a bad epidemic? How often do they occur? How did goats perform during a major drought?, etc.

Local experts may also be helpful in describing different husbandry practices and why they are carried out in the way described; for example, care of newly-born kids or local treatments for disease.

3.2.11 Direct observation

It may seem strange to include observation as a separate method of collecting information, but people do not use their eyes and other senses enough. Close observation of the way in which people manage their goats is very important and can lead to more relevant questioning of the farmer. Sometimes unobservant recorders may be conducting an interview and writing down an answer that directly contradicts what is happening in front of them. This may not mean that the farmer is not telling the truth (although it may!), but could just mean that the question needs to be expanded and asked in more detail. Perhaps under certain circumstances a practice like supplementary feeding is done in one way and in other circumstances done in another way. Or perhaps one member of the family, for example the wife, does it one way and others in another. This is why it is necessary to question the relevant person involved in goat management within the family. Observation can help in cross-checking farmers' responses with reality.

3.2.12 Maps and walks

It is useful to gain an understanding of the physical arrangement of the village or locality. It may be important to know the distances to grazing and water points, particularly in pastoral systems, where the grazing and water resources are under communal ownership and where the goat owners' main management strategies are concerned with manipulating the use of grazing, water, and house location.

A group or individual can be asked to draw a simple map of the village or locality on a piece of paper, or on the ground with a stick. Important areas for goat production can be entered on the map. These may include areas of grazing/browsing particularly suited to goats, places where goats get sick, places in the river where goats can be watered, local mineral licks, the site of a dip tank, and places where farmers may wash their goats. Gradually a picture of the physical environment emerges; this impression can be matched to,
or drawn on, a published map, if available. Once these places have been identified, you should visit them on foot to learn more.

3.2.13 Problem analysis and objectives analysis

By now you should have a considerable body of information about goat-keeping in the area. Some of it will be qualitative information from group discussions and interviews, complemented by quantitative information on individual flocks, their size, structure, and performance. It is helpful to draw this information together in the form of a diagram or series of diagrams to illustrate core problems. This is sometimes known as problem analysis. Problem analysis helps to:

- analyse the existing situation affecting a general problem of goat-keeping;
- identify the major problems;
- define the core problem(s) of a situation;
- visualise the cause-effect relationships in a diagram or problem tree.

First identify the major problems of goat-keeping in the area. The causal chains developed in the group discussions (3.2.7) could be the starting point, but information from all the sources should be used to build up the most thorough possible picture of goat-production problems. Try to identify one core problem and focus on it. If you are not happy to identify only one problem, add one or two more; but you are likely to find that they are linked anyway. Write down the causes of the problem and then write its effects. Draw a diagram showing the cause and effect relationships in the form of a problem tree. The causal chains may form the branches of the problem tree. This could be done with farmers and/or a group of colleagues. It is always better if a small group develops the problem tree. This will give it greater validity and completeness. An example of a simple problem tree is given in Figure 3.8. At this point you may find that multiple core problems are linked together: perhaps one is the cause of another, or possibly the effect. Try to concentrate on one important core problem and tackle that one wherever possible.

Next consider how these problems might be tackled by individual farmers, the community, and/or development agencies. This is sometimes known as objectives analysis. It helps to describe the future situation and to identify potential alternatives for a project or programme. Objectives analysis simply restates all the problems into objectives, i.e. positive, desirable, and realistically achievable conditions. The cause-effect relationships become means–ends relationships. Check that they are valid. At this point additional objectives can be added which might not directly solve
Figure 3.8 Problem analysis: low milk production

**Effect**

- High levels of child malnutrition
- High kid mortality
- Slow kid growth
- No milk to sell

**Core problem**

- Low milk production

**Cause**

- Poor health
- Irregular watering
- Breed type
- Poor nutrition

- High incidence mastitis
- Heavy internal parasite burden

- Low feed intake
- Low protein levels in dry-season feed
- Low energy levels in feed

- Poor hygiene

- Communal grazing
- Irregular drug supply
- Low household income

- Feed scarcity
- Extensive cultivation
- Heavy grazing pressure

- Water scarcity

- Water pump broken down

- High human population

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an identified problem but may be an additional opportunity for improving the situation. In the example in Figure 3.9, forage development is introduced not as a positive aspect of something negative, but as a new opportunity to improve the situation.

The objectives analysis can form the basis for planning a programme or project. This will be discussed in Chapter 11, when alternative technical and organisational options are considered and methods of participatory planning discussed.

3.2.14 Reporting

It is helpful to record the information you have collected into some sort of report, either handwritten or typed, for circulation to your colleagues for comment. The report might take the title 'A Profile of Goat-keeping in ...' and could adopt the following structure:

- **Introduction**
- **Objectives**
- **Physical background** of area, probably from secondary data collection and direct observation, including rainfall, roads, markets, maps, general description of the farming system
- **Methods** used in field; dates, timing, personnel
- **Results**
  - General description of goat-management system
  - Goat ownership, distribution within community, flock sizes
  - Flock structures
  - Progeny-history results
  - Feed calendars
  - Disease calendars
  - Economic uses of goats
- **Conclusions**
  - Major constraints on goat production identified with the community
  - Possible interventions
  - Areas for further study

Such reports are important documents, because they record the information that led to the initial actions taken. Information will constantly be added, but it is important to take the time to write an accurate report, including all the diagrams developed during the course of the investigation. The report will be referred to in the future and may form the basis for planning and funding a project.

3.2.15 Community consultation

Once you have spent time with the community learning about their goat-keeping and have collated the information into a simple report, you should return to the community as soon as
Low-cost methods of assessing goat-production problems

Figure 3.9 Objectives analysis to increase milk production

End

- Reduced child malnutrition
- Reduced kid mortality
- Faster kid growth
- Excess milk to sell

Main objective

- Increase milk production

Means

- Improve health
- Regular watering
- Improve breed characteristics
- Improve nutrition

- Reduce incidence mastitis
- Reduce internal parasite burden
- Farmer training in strategic drenching
- Increase intake
- Increase protein levels in dry season
- Increase energy intake

- Improve hygiene
- Improve drug supply
- Forage development
- Feed waste fruit, roots, household waste

- Regular water supply
- Increase feed supply

- Farmer training
- Regular water-pump maintenance
- Training in pump maintenance
- Organise water committee
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possible and present your results and conclusions to them for their comments. This might be done at a public meeting, where wider issues raised during the RRA can be discussed. It might also be done at group discussions. Learning never ends, and you should not be afraid of admitting that you do not know things and that you need to learn more. However, we also learn by doing, and at some point the community will expect some action and should not be disappointed! Once a real problem has been identified, however trivial, if it can be solved it should be tackled without delay. You will learn more about the problem by trying to solve it than by continuing passive research.

3.2.16 Have a go!

We have looked at the sorts of information that can be collected with few resources other than a pencil and paper. A lot can be learned from these simple techniques. This should encourage you to have a go at goat development, even if you do not feel that you have many resources to help you.

3.3 Higher-cost methods of assessing goat-production problems

The Rapid Rural Appraisal (RRA) techniques described in 3.2 provide a quick way of taking a first look at goat production in an area. They require very few resources, and can be done at village level by one person or at district level by a small team. The information acquired is largely qualitative, and indicates some of the problems of goat production.

However, RRA techniques may not always provide accurate diagnoses of all problems. For example, a disease calendar may give a picture of the main diseases, perhaps using local names, and the seasons during which they are most prevalent. But this may not lead to an accurate identification of the disease. In order to develop an effective control programme, blood or faecal samples may need to be taken, possibly at different seasons, for an accurate diagnosis of the disease and a record of its seasonal incidence. Likewise, if farmers complain of a shortage of feed in the dry season, it might be helpful to analyse the feeds in a laboratory to assess their digestibility or estimate any protein deficiencies. In addition, weighing a sample of lactating females at the start of the dry season and again at the end will accurately show their weight loss, and the effects of this on milk production as well as the effect on kid mortality. RRA techniques provide a one-shot view of a situation, but are less accurate in describing the seasonal dynamics of that situation. For this, a longer-term monitoring study is needed.
Higher-cost methods of assessing goat-production problems

What can be done, if external support is available, to diagnose problems of goat production accurately? Table 3.1 outlines a procedure for monitoring goat production. It should be kept as simple as possible. Regular monitoring of aspects of production will provide more accurate information on the technical constraints on goat production. Where relevant, the procedure, ideally, would involve technical specialists. They might include a veterinarian with access to a diagnostic laboratory, an animal nutritionist with access to a feed-analysis laboratory, and finally someone to help analyse the productivity data with access to a computer and appropriate software. You do not need these specialists all the time, but should draw up a work-plan with them and involve them as required. The procedures described do not form a complete livestock-systems research procedure, which is a specialist activity requiring a lot of resources (ILCA, 1990, p. 399). The procedure proposed could be followed by a livestock extension officer with access to laboratories able to carry out fairly basic analyses. Many donor-funded projects now include a flock-monitoring component during project preparation and implementation (see Chapter 11).

If you are working with particularly needy communities, you may find it morally and practically difficult to carry out a longer-term monitoring study of goats without doing something practical for the community at the same time. There is no reason why you cannot simultaneously initiate some practical improvements, based on the results of the RRA, and also carry out a long-term study of goat production. However, you should be aware that the interim intervention may affect the results of the monitoring.

Research scientists like to try to keep monitoring and intervention as separate activities, but in practice it is hard to do so, and they can be complementary. By regularly visiting a goat flock, outsiders are already making an impact on it. If a practical intervention is introduced, much can be learned by monitoring the impact of the intervention on the goats, the farmer, and the farmer’s family. This will improve the efficacy of the intervention itself. There is always concern that the effect of the intervention on the goats cannot be measured if the performance of the goats before the intervention is unknown. In fact, it is known by the farmer. The farmer is the best judge of an intervention, because, if the intervention is not perceived to be an improvement by the owner, it has little value. It is vital that the farmer and his or her family are involved in evaluating any improvements made. How to involve farmers in evaluation will be discussed in more detail in Chapter 11.

3.3.1 Selection of sample sites

There is little point in carrying out a monitoring study of goats in order to identify the problems of goats in only one village. It is
assumed that you are concerned with more than one village and most likely a district or region. There are a number of questions to consider:

- How much environmental variability is there within the area?
- How much economic variability is there?
- What resources (personnel, money, transport) are available?
- How long can the monitoring last?

Classify the main goat-production systems of the district, however crudely. There may be, for example, a section of highland where crops are grown and goats are mainly tethered, and a lowland area where agro-pastoralism may be practised. Refer to your original objectives and select areas and flocks that meet them best. Focus your resources on monitoring flocks that come from the most relevant production systems of interest to you.

3.3.2 RRA procedures

Section 3.2 described the procedures to follow in acquiring a quick general picture of goat production in an area. Follow the steps outlined in that section: the results from the RRA will help in planning the monitoring study. It is important that public meetings and group discussions are held at the start of a longer-term monitoring study. The rapid flock-appraisal visit can be used to set up the monitoring study.

3.3.3 Setting objectives

Having had discussions with the community and with smaller groups of farmers, you should by now be able to identify particular areas of interest that require further study. Clearly define your objectives. This is very important in deciding what information you need to collect, how often it should be collected, and who is able to collect this information with an acceptable level of accuracy. There is so much information that could be collected about a goat flock and its management and productivity, but to make efficient use of your resources you must focus on key topics.

3.3.4 Sampling size and recording frequency

If you plan to set up a long-term study of flock performance, the selection of households willing to cooperate in the study is essential. The same principles of selection of sample size and composition apply here as were described in 3.2.8. In addition the following points need to be considered when deciding sample size and composition for a monitoring study:
Higher-cost methods of assessing goat-production problems

• average number of goats per household;
• arrangement of households: in village, dispersed, nomadic;
• number of staff, local recorders;
• transport needed and available;
• desired frequency of data collection;
• management system: housed or herded (all/part of day);
• degree of farmer cooperation.

3.3.5 Farmer participation

It is essential, in a long-term monitoring study, that you have good cooperation from farmers throughout the recording period. It is a waste of resources to start recording a flock, only to lose access halfway through the study because the farmer gets bored or angry with the frequent visits. Keeping farmers involved and interested in the study is essential. There are many ways of doing this. The purpose of the study has to be clearly explained to the farmer and any suspicions allayed. Make clear what cooperation you need from the owner's family. Do they merely have to allow access to the flock every month, or does someone have to report if any goats get sick? Make this clear and then ask if they still agree to the study. In some cultures, livestock staff have found it necessary to offer some sort of incentive to farmers to get and maintain their cooperation. This should not be necessary in the context of a development programme, where the farmer and the community should receive some tangible benefits from the results of the work. If the study is purely for research purposes, with fewer practical benefits at the end, then incentives might have to be given. These may take the form of veterinary treatment for the flock, small gifts of hoof trimmers, buckets, etc., or even money. However, if gifts are made, it is very easy for the relationship with the farmer to turn quickly from one of mutual collaboration to one of paternalistic intervention. This should be avoided.

3.3.6 Setting up the monitoring study

Once the objectives of the monitoring study have been clearly defined and the resources available for the work are known, the data to be collected and the frequency of collection need to be decided.

At the core of any monitoring study is the collection of basic data on the productivity of the goat flock. These data can be collected fairly easily during regular visits to the flock. So how often should you go? The more frequently you visit, the more accurate will be the information, particularly in larger flocks where there are many births and deaths. A monthly visit is probably adequate for most purposes, but more frequent visits would be even better and are
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Components of flock productivity

<table>
<thead>
<tr>
<th>Reproduction:</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of kids born</td>
</tr>
<tr>
<td>frequency with which dams give birth</td>
</tr>
<tr>
<td>proportion of potential breeding does actually giving birth</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Growth and weight changes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>growth rates of young animals</td>
</tr>
<tr>
<td>seasonal weight loss and gain of adults</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mortality:</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of deaths</td>
</tr>
<tr>
<td>age at which goat died</td>
</tr>
<tr>
<td>cause of death</td>
</tr>
<tr>
<td>season of death</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Morbidity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>incidence of sickness</td>
</tr>
<tr>
<td>age of sick goat</td>
</tr>
<tr>
<td>cause of sickness</td>
</tr>
<tr>
<td>season of sickness</td>
</tr>
</tbody>
</table>

necessary to record the incidence of disease. A two-level recording system is often a useful approach to take: a local person, even a member of the family, records daily events such as births, deaths, and diseases, and a monthly visit is made to the flock by a team with a weigh-scale, when records are up-dated and checked.

Weighing the whole flock can take some time and requires the use of weighing equipment, and a means to transport it. It may not be necessary to weigh the whole flock every month. You can reduce the frequency of weighing and the animals to be monitored by weighing a sample from the flock at strategic seasons. For example, the growth-rate of kids is a good indicator of the milk production of the dam. If milk is an important product, then kid growth should be measured at least until weaning. If there are marked wet and dry seasons, seasonal changes in weight can be an important factor, especially in breeding females. If they are losing weight, they may not be able to conceive; or if they are losing weight during lactation, the kid may get little milk, making it weak and susceptible to disease and death. Kids and breeding females are usually the goats most in need of supplementary feeding. It is important to find out if they do have problems. You will have to decide if it is easier to weigh only particular goats at particular seasons, rather than the whole flock every month.
Higher-cost methods of assessing goat-production problems

A similar form to that used for the flock structures and progeny histories can be used to start a monitoring study, with the addition of columns for the following:

- tag number
- colour
- presence of horns/toggles/beard
- weight.

The field method is the same as for the rapid survey, with the addition of tagging or marking each goat and weighing the flock.

3.3.7 Goat identification

It is of vital importance that each goat to be recorded can be accurately identified in the flock and in all the records. Ideally each goat would have a number on it. In small flocks, where farmers might give their goats names, it might be possible not to number the goats but to rely on names and convert the names to a number for analysis, but this is not ideal. There are several ways to identify goats:

- ear-tags (plastic or metal)
- collars (chain or leather)
- tattoos (in ear or under tail)
- brands (hot or freeze brands)
- ear notching.

Each method has certain advantages and disadvantages. Tattoos, brands, and ear notching are permanent, but may be disliked by farmers. Metal ear-tags are preferred over plastic ones, which can easily be removed, and often are, by children for toys or jewellery (Figure 3.10). However, some farmers do not like ear-tags at all. If ear-tags cannot be used, a small collar might have to be used.
## Initial format for goat monitoring

<table>
<thead>
<tr>
<th>Owner's name</th>
<th>Village</th>
<th>Recorder</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag no.</td>
<td>Sex</td>
<td>Tooth age:</td>
<td>Colour</td>
</tr>
<tr>
<td>Male</td>
<td>Female</td>
<td>Castrate</td>
<td>MT suckling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</table>
Higher-cost methods of assessing goat-production problems

These are not very reliable, as they can easily be removed, but may be useful in certain circumstances; they have the advantage that they can be made from local materials.

It is important to record a physical description of each goat (colour, presence/absence of horns, toggles, beard, mane, etc.), in case its ear-tag or collar is lost.

3.3.8 Weighing goats

The simplest method of weighing a goat is to use a canvas or leather sling and a spring balance. The spring balance can be hung from a tree or suspended from a metal tripod. The dimensions for a sling and tripod are shown in Figures 3.12 and 3.13. Small pocket spring balances can be used to weigh kids.

There are other, more expensive, methods of weighing; they include a special mobile crush and weighing platform or the use of load-cells underneath a platform with a digital read-out. Really sophisticated weighing machines can even be linked to a data-logger for direct transfer to a computer, but these are very expensive and not always reliable.

Goats should be weighed at the same time of day every time they are weighed. In one day they can eat and drink a weight equivalent to 15 per cent of their body-weight, so it is best always to weigh them early in the morning before they go out grazing or are watered, to obtain a standardised weight. Regularly check the accuracy of the scales against a known weight, to make sure they are giving you accurate readings.

In some countries scientists have developed equations that allow the measurement of the chest of a goat, known as heartgirth, to be converted into an estimate of its liveweight. Table 3.7 presents a table for conversion of a heartgirth measurement (cm) into a weight (kg). The goat should be standing square and a simple tailor’s measuring tape put around its chest, just behind the front legs. This method gives only an estimate of the goat’s weight. It can be combined with condition scoring to provide a more accurate picture of changes in the weight and condition of a goat.

The body condition can be assessed by the look and feel of the area around the backbone behind the last rib and the area around the tail area. These are good places for estimating the relative amount of fat carried by the goat, which gives an indication of its condition. It is quite a simple technique, but it is a subjective method that relies on the opinion of the recorder. It is best if the same animals are always assessed by the same recorder, in order to reduce the subjective element in the technique. Condition scoring can provide only relative measures of the body condition of the goat and so is best used to make a rough assessment of the effect of seasons on the goat’s body condition. However, it is hard to compare scores between flocks recorded by different people.

<table>
<thead>
<tr>
<th>Heartgirth measurement (cm)</th>
<th>Weight equivalent (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>20.0</td>
</tr>
<tr>
<td>65</td>
<td>22.5</td>
</tr>
<tr>
<td>68</td>
<td>25.0</td>
</tr>
<tr>
<td>70</td>
<td>27.5</td>
</tr>
<tr>
<td>72</td>
<td>30.0</td>
</tr>
<tr>
<td>76</td>
<td>35.0</td>
</tr>
<tr>
<td>80</td>
<td>40.0</td>
</tr>
<tr>
<td>84</td>
<td>45.0</td>
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<tr>
<td>88</td>
<td>50.0</td>
</tr>
<tr>
<td>91</td>
<td>55.0</td>
</tr>
<tr>
<td>95</td>
<td>60.0</td>
</tr>
<tr>
<td>98</td>
<td>65.0</td>
</tr>
</tbody>
</table>
Assessing goat-production problems

Figure 3.12 Construction of a weighing sling (canvas and leather)

Figure 3.13 Construction of a tripod

Figure 3.14 Weighing a goat with a sling and a spring balance

JENNY MATTHEWS/OXFAM
Higher-cost methods of assessing goat-production problems

Table 3.8 Body-condition scores for goats

<table>
<thead>
<tr>
<th>Score</th>
<th>Backbone</th>
<th>Tail area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Backbone very sharp and prominent; fingers easily pass under the ends of the top of the vertebrae, which are sharp. NO FAT COVER</td>
<td>Very bony pelvis, with a deep hole either side of the tail</td>
</tr>
<tr>
<td>2</td>
<td>Backbone still prominent, but ends of the top of the vertebrae are rounded; fingers can still pass under them with a little pressure. MINIMUM FAT COVER</td>
<td>Pelvis still bony, but holes either side of tail filling</td>
</tr>
<tr>
<td>3</td>
<td>Backbone well covered and smooth; ends of vertebrae tops not felt unless firmly pressed. MODERATE FAT COVER</td>
<td>Pelvis os more rounded, with hip muscles developing</td>
</tr>
<tr>
<td>4</td>
<td>Backbone not visible. Back well rounded. End of vertebrae tops cannot be felt. THICK FAT COVER</td>
<td>Pelvis well rounded and hip muscles well developed</td>
</tr>
</tbody>
</table>

3.3.9 Continuous monitoring

After the initial visit to record flock structure and progeny history and tag the goats, a simple register of the flock can be made. Every goat in the flock should be checked against the register, to determine presence or absence in the flock. If it is absent, questions can be asked about the reason (death, sale, etc.); any new goats found in the flock, but not on the register, can be added to the register and the reason for their presence given. A flock register is the only way to keep track of events in the flock. It is essential in large flocks and helpful in small ones.

A regular timetable of visits to the flocks in the area should be drawn up and agreed with the owners. Time and place should be at the owner’s convenience and create as little disturbance to the family’s routine as possible.

Design the formats to be used so that they are easy and accurate to complete by the recorder in the field. They should also be weather-proof and goat-proof. Always make a copy of the record taken at every visit, in case the original copy is lost or eaten by goats (it has happened!). Some people find printed cards are strong and hard to lose; others like bound record books. Some basic formats are shown in Figure 3.15 as a guide.

3.3.10 Milk measurement

If milk is an important product, it should be measured as accurately as possible to gain a good understanding of the
Assessing goat-production problems

Figure 3.15 Some formats for monitoring goat flocks

<table>
<thead>
<tr>
<th>Flock inventory</th>
</tr>
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<tbody>
<tr>
<td><strong>District</strong></td>
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<tr>
<td>Tag no.</td>
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Additions to flock: Births and abortions

<table>
<thead>
<tr>
<th>Village</th>
<th>Owner</th>
</tr>
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<tbody>
<tr>
<td>Date of birth</td>
<td>Tag no.</td>
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Additions to flock: Purchases, gifts, loans, etc.

<table>
<thead>
<tr>
<th>Village</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of birth</td>
<td>Reason for entry</td>
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<tr>
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</table>
Higher-cost methods of assessing goat-production problems

Removals from flock: Death

<table>
<thead>
<tr>
<th>Village</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of death</td>
<td>Tag no.</td>
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Removals from flock: Sales, gifts, loans, etc.

<table>
<thead>
<tr>
<th>Village</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of removal</td>
<td>Reason for removal</td>
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The milk output per day and the length of the lactation must be known, if you want to calculate the total milk output per lactation. It is relatively easy to measure milk off-take, but much harder to measure the total milk production of the dam when a kid is suckling part of the milk. Various techniques can be used to estimate the amount of milk suckled by the kid, none of them very accurate.

**Weighing before and after suckling:** suckling animals are weighed on a sensitive scale, before suckling and again after suckling. The gain in weight is assumed to be equivalent to the amount of milk consumed. Care needs to taken to measure the kids quickly after suckling, before they urinate or defecate. This technique requires close supervision and a lot of labour.

**Bottle feeding:** the dam is milked out completely by hand, and the kid is bottle-fed. This is an unnatural situation and it is unlikely that the dam will let down all her milk as she would if she was being suckled. This method is therefore likely to give an underestimate of total milk production.

**Partial suckling and liveweight equivalents:** by knowing the growth rate of the kid, it is possible to estimate how much milk was consumed to produce that growth. A useful equation is shown in the box on the next page.
Assessing goat-production problems

Total milk yield for first 6 weeks' lactation = 

\[
\frac{\text{Weight of kid at 6 weeks} - \text{birth weight} \times 1.2}{0.13}
\]

(based on a milk : growth conversion ratio of 1.2, and assuming there are 13 per cent solids in the milk)

This method can be used only during the first few weeks of lactation, when virtually all the kid’s nutrients are obtained from the milk. Once the kid starts nibbling at other feeds and developing an active rumen, this method will not be accurate.

The milk that is taken for human consumption can be measured by weight or volume. Weight is generally considered to be more accurate than volume, but volume is usually easier to measure in the field. It is best if the recorder is present at milking and can observe the methods used. Is the kid present? Is it suckling at the same time as milking? Does the kid always suckle one teat, and the milker always milk the other teat?

After milking, the milk should be measured before it is mixed with milk from other goats. Some farmers will pour their milk only into their own container. Many farmers and pastoralists treat their calabashes or gourd containers in some way, smoking them for example, and do not like milk to be poured first into a plastic measuring jug. In this case it will be easier to weigh the milk by weighing the container before and after milking. Some goat keepers will milk into a container of known volume, a tin can for example, and this can be used for measuring the milk. You may also find traditional units of measurement which can be used to estimate milk volume, provided that the unit is the same on all farms.

3.3.11 Investigating and monitoring disease

The purpose of disease investigation and monitoring is to find out if disease is a constraint on goat production in the area, and whether cost-effective measures can be taken to control the main diseases. There are three steps to this.

- Identify the main diseases and their causes.
- Identify which goats are affected.
- Quantify the effects of the main diseases.

Diseases can affect goats by killing them (mortality) and by making them sick (morbidity). Diseases can be regularly found in a region (endemic), or occur at a much higher rate than normal (epidemic). Goat health is covered fully in Chapter 6. At this stage
Higher-cost methods of assessing goat-production problems

... it is important to think about designing a study that enables the recording of mortality and morbidity rates for both epidemic and endemic diseases. There are basically two approaches that can be taken: a one-shot disease survey, or a more extended disease-monitoring study.

One-shot disease survey
A one-shot disease survey covers a large number of goats, and uses the RRA techniques of group and individual interviews with farmers, together with sampling of blood, faeces, skin scrapings, external parasites, etc. This can give a picture of the prevalence of diseases at one point in time. Goats can be physically examined and samples taken from them for analyses. If this is combined with interviews with individual farmers and group discussions, a reasonably informative disease picture may emerge. The main weakness is that it gives an accurate indication of disease incidence at one point in time only, and so the seasonal dynamics of diseases, which can be very important, are not understood. The survey can be repeated at different seasons, in which case a more dynamic view will be obtained. However, if a productivity-monitoring study is being undertaken, it is relatively cheap and simple for a disease-monitoring study to be incorporated.

Extended disease monitoring
A disease-monitoring study of the incidence of disease in a small number of goats over at least one year should record the name of the disease (including local names), the symptoms, treatment, and outcome; there might be regular sampling of blood, faeces, and external parasites, as well as sampling at the time of disease and death. It is relatively simple to add to a basic productivity-monitoring study a few simple steps that record disease incidence, morbidity and mortality. You can use the local name of the disease, combined with a description of the basic symptoms, whether any treatment was given, and the outcome of the disease. However, this sort of information is not sufficient to make a definitive diagnosis.

It should be possible to group the diseases into disease types (respiratory, intestinal, skin, etc.). This will give a basic picture of disease incidence and whether any deaths were caused by disease or non-disease factors. Appropriate samples should be taken to provide more specific identification of diseases.

Sample collection
Samples taken from the body of a goat can provide an accurate picture of the past and present incidence of disease. As the collection and preservation of samples can be expensive and difficult in the field, collect only the samples that you really need, and ensure that they are sent to a reliable laboratory, able to do the
assessing goat-production problems

Tests you want. Always find out what tests can be done by the laboratory to which you will send the samples, and take only the samples that are appropriate for those tests. There are three categories of sample that can be collected:

- serological samples: blood-serum samples to analyse antibodies and determine the goats' previous exposure to diseases;
- samples to identify disease agents such as viruses, parasites, bacteria, etc. that are on or in a goat;
- indicator samples, to show the likely cause of a disease or its severity; for example, the Packed Cell Volume (PCV) will indicate if there are any blood-sucking parasites in the goat's body, but not which parasites.

The regular or seasonal sampling of faeces, blood, or external parasites can be extremely helpful in understanding the seasonal incidence of diseases of major importance. Goats are particularly susceptible to internal parasites, and the regular collection of faeces for examination in a laboratory can be helpful in building up a picture of the seasonal incidence of different parasites. This can be used to design a strategic, cost-effective drenching regime (see 6.4.1). Likewise the seasonal collection of ticks to identify the major species at different seasons can be useful, if combined with a quantitative estimate of tick incidence, for predicting the seasonal incidence of tick-borne diseases. In deciding which samples to collect, you should be guided by the experience of local veterinarians, combined with information from the farmers themselves.

The design and management of the sampling should be supervised by an experienced veterinarian, who would be responsible for ensuring the proper laboratory analyses of the samples. Sensitivity needs to be exercised with farmers when sampling, particularly in taking blood samples. Some farmers will simply refuse to allow their goats to be bled. Others may allow it once but not regularly — as would need to be done in monitoring trypanosomiasis. Explain clearly why you are taking the samples and that it will do no harm to the goat. Report results quickly and explain them to the farmer, so that it becomes a joint process of learning about the health of the flock. Do not push too hard if the farmer is reluctant. You can lay yourself open to being blamed by a disgruntled farmer for deaths and diseases in the flock for which you are not responsible.

Practical sampling techniques and proper handling of samples are described in Chapter 6.

Sampling at time of disease or death
To obtain an accurate diagnosis, it is ideal for an experienced veterinarian or veterinary assistant to see the goat and take
appropriate samples at the time when it is actually sick. In order to achieve this, it is necessary for the veterinary professional to be alerted to the sickness and be able to travel quickly to the goat. This responsiveness is not always possible to organise.

It is also ideal if an experienced person is able to undertake a post-mortem examination of a goat that has recently died. If this is done and samples are taken to a competent laboratory, it should be possible to establish a definitive cause of death. Post-mortems can be carried out by anybody, and the procedure to follow is described in 6.6.2. If a more experienced person is not available, it is better for the farmer or extension staff to do the post-mortem than that it is not done at all.

**What to do with the data**

After at least one year of disease monitoring and sampling, you should be able to estimate:

- morbidity rates by disease type, goat age/sex, season;
- mortality rates by goat age/sex, season.

These will tell you:

- the most important diseases;
- the seasonal incidence of these diseases;
- which goats are most affected by which diseases.

This information can then be combined with the productivity recording (milk, growth, reproduction). It is hard to define the exact causal relationship between a disease and its effect on production. Diseases often have indirect effects on productivity. For example, internal parasites in a lactating dam will considerably reduce milk production, which in turn will lead to malnourishment in the suckling kid, possibly causing it to die. That is an indirect effect of parasite burden on kid mortality. It can be hard to quantify the effect of disease on production in order to put a monetary value on the cost of the disease.

Once the important diseases are known, it should be possible to sit down with a veterinary professional and design disease-control strategies for the most economically significant diseases. Diseases do not always have to be controlled by the use of drugs. Often it is small improvements in management which can be the cheapest way of controlling disease. Strategies for the control of major diseases of goats are discussed in Chapter 6.

**3.3.12 Feed monitoring**

The proper feeding of goats is of fundamental importance to successful production, but the quantity and quality of feed actually consumed by a goat can be very difficult to measure in the field.
Assessing goat-production problems

Measurement is much easier in systems where goats are housed or tethered, and feed is cut and carried to them. If they are free-grazing or tethered to graze, then it is very difficult and expensive to make any sort of estimate of their intake rates and quality of the diet consumed. Ideally feed monitoring would record feed intake (dry matter consumed) and diet quality (protein and digestibility) for different classes of goats and at different seasons.

**Housed goats**

If goats are housed, it is relatively easy to measure the amount of feed they eat. The quantity left over, subtracted from the quantity offered, tells you the quantity consumed.

Samples of offered and left-over feed should be taken and analysed for digestibility, where possible. Care needs to taken in collecting a representative sample of the feed. Fresh forage should be weighed to obtain its fresh weight (FW). If it cannot be transported to a laboratory on the same day, it should be placed in a porous bag (paper or cloth will do) and dried in the sun. Once it reaches the laboratory, it should be dried in an oven at 65°C to a constant weight. This is the weight of dry matter (DM). The dry matter can then be analysed, using laboratory techniques. The advantages and disadvantages of different methods of laboratory analyses will be discussed in Chapter 4.

If you are taking feed samples from a stack of crop residues or hay, take care in your sampling procedures to obtain representative samples from the pile. Take from the middle and edges as well as the top and bottom.

**Grazing goats**

Measuring the amount of feed consumed by grazing goats and the quality of the diet selected is very difficult. The most sophisticated technique is fistulation, whereby a hole is made in the oesophagus and/or rumen of the goat, and samples of feed actually consumed are taken at different stages (see 4.6). Fistulation has been carried out very rarely on goats on research stations and even less often in the field.

Grazing observations can be carried out to estimate the amount of time spent grazing and the distance covered by the flock in the course of a day. The distance covered by pastoral goat flocks in the dry season can be considerable, up to 10–15 km/day. Walking long distances can have a significant impact on production.

**3.3.13 Management monitoring**

There are many aspects of goat management in addition to the basic requirements of feeding and health. The RRA discussions might perhaps highlight one or two aspects of management for
special, detailed study. For example, it may be relevant to record
the time spent by various members of the family in looking after
their goats. Or a breeding problem might have been identified,
perhaps a shortage of breeding bucks, and it might be necessary to
record from where the breeding male is obtained. Special formats
and procedures should be developed for each activity.

3.3.14 Marketing studies

It might be considered necessary to study the marketing of goats
and goat products in an area. Prices could be monitored at a
weekly market over several seasons to determine the terms of
trade for goat keepers of livestock for grain, or the trading margins
of traders. Milk, butter, or cheese prices may also be monitored for
seasonal fluctuations and profit margins of traders. Be careful
when interpreting the data. Because a trader makes a profit does
not mean that he or she is exploiting the farmer, although it may!
Traders perform many useful functions for farmers which might
be difficult for farmers to do for themselves.

3.4 On-farm trials of improvements

Once problems have been identified and solutions to those
problems designed, it is best if innovations are tested with a small
group of farmers before they are disseminated to a larger number.
There are many types of trials that can be carried out on farms,
from highly controlled, statistically analysed exercises to simple
trials with a few farmers giving their opinion on the innovation.
Statistically valid trials on livestock are notoriously difficult to
organise and should be left to research organisations. They
require a relatively large number of goats and/or farms to be
involved, precision in the application of the treatment, and the
control of any external factors which may affect the results of the
trial. In the real world, these conditions are hard to achieve and
the trial will require many resources to supervise and record it
accurately.

Simple trials using a small group of farmers willing to try out an
innovation can be carried by development-orientated organisa-
tions. The effect of the innovation can be evaluated jointly by the
farmer and extension staff. The farmers can also modify the
innovation and make their own improvements to it. Farmers' percep-
tion of the effect of the new method is all-important,
because that will determine the likelihood of its being adopted by
other farmers. Innovations such as the use of feed supplements,
the use of anthelmintics, or improved goat-house designs can all
be tested with a few farmers before wider distribution to many.
Further reading


Basic nutrition

Introduction

Feeding goats well is of fundamental importance to the success of the whole goat enterprise. Good nutrition is a prerequisite for good health, good reproduction, high milk yields, fast growth rates, and a successful goat system.

Most textbooks on goat production and animal nutrition in the tropics approach the improvement of nutrition in a classical European way, by itemising the nutritional requirements of goats in terms of energy, protein, vitamins, minerals, and water at different stages of their life: pregnant, lactating, or growing. After listing what the goat should ideally eat, these books proceed to formulate rations composed of several different feeds which will provide the identified nutrients. This approach implies that farmers in the tropics are able to follow 'demand-driven' recommendations for goat feeding in the same way as a farmer in Europe or the USA is able to, by buying different feeds and making a ration from them. Unfortunately most farmers who keep goats in the tropics are not in a position to pick and choose the feeds they give to their goats according to the energy or protein content of each feed.

Farmers keeping goats in the tropics make use of the natural grazing and crop by-products that are available, and try to feed their goats as best they can with what they have. This might be termed 'supply-driven' feeding, as goats are fed according to the supply of feeds available, over which the farmer may have little control. Farmers can be helped to make more efficient use of the available feeds and to increase the supply of feeds by growing forage crops; but encouraging the use of a formulated ration is not helpful in most situations.

This chapter takes a very practical approach to feeding goats. You do not have to be a highly qualified nutritionist to be able to feed a goat properly. A basic understanding of the contents of different feeds, how the goat likes to eat, and how it digests different foods can provide sufficient understanding to make the
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best use of the feeds available. Guidance is given on making simple calculations of need which provide a practical framework of reference, and how to make the best use of the feeds available. Consideration is also given to the special needs of lactating does, kids, and fattening stock.

The next chapter describes how the feed supply itself can be improved to match the demands of the goats through the year, by planting forage crops, controlling livestock, and conserving and storing feed. It is possible to read Chapter 5 first for ideas on how to feed goats better. But for a better understanding of many of the interventions suggested in that chapter, this chapter should also be read.

4.1 The feeding habits of goats

It is important to understand the feeding habits of goats, so that when they are cared for by people, particularly when confined in a house, their natural habits can be copied as closely as possible, and they are comfortable and healthy.

The goat, being a ruminant, is able to live and be productive on fibrous vegetation of relatively poor quality. The goat is a natural browser, feeding by preference on tree leaves, flowers, and seed pods, when it can. Goats are able to eat quite woody stems of trees and bushes. They are very active when they eat, moving rapidly round a tree, picking off the best parts, and quickly moving on to the next tree or bush. Goats naturally prefer to eat at a height 20–120 cm above the ground. They can stand on their hind legs for long periods, and even climb into trees in order to reach some particularly delicious part of the tree (Figure 4.1). Goats find it difficult to eat directly off the ground, normally bending down on their knees to do so (Figure 4.2). They have a very mobile upper lip and tongue, allowing them to consume leaves between thorns. When left to themselves, goats are able to find a diet of reasonable quality by making a selection of the plants, and the parts of plants, which they eat. In the same environment goats will consume many more species of plants than sheep, grazing the same area. Goats have wide-ranging tastes in food and can adapt to eating unusual foods, such as tree bark and cloth, in extreme conditions.
Figure 4.2 Goats kneeling to eat from the ground
JENNY MATTHEWS/OXFAM

Figure 4.3 Feeding heights (in centimetres above the ground) of sheep, goats, cattle, and camels
Sometimes it is thought that, because goats eat so many things, they will eat anything. This is not true. They will refuse even lightly soiled feed. They prefer to be selective and are easily bored by having to eat the same feed every day, unless it is one they particularly relish, such as alfalfa or desmodium. If feed is of uniformly low quality, goats may spend a lot of time trying to select high-quality material and in the process not eat very much.

The goat's preference for consuming browse can be put to good use in the control of bush species invading grassland. Keeping a mixture of grazers and browsers can maintain rangeland grazing areas as grassland, rather than allowing them to become overgrown with bushes. Goats have been used in Australia by graziers to control blackberries. The mixed species of livestock kept by many pastoralists in Africa have the same effect. Pastoralists usually keep several species, enabling them to exploit several ecological niches at the same time. In arid environments, keeping camels allows the exploitation of vegetation above the browsing range of goats, so there is no competition between them and an even pressure is maintained on the scarce vegetation.

4.2 The feeds available to goats, and their characteristics

Goats consume many different types of feed in the tropics and are allowed by their owners to eat those feeds in many different ways. Goats may browse and graze freely throughout the day (and sometimes the night), or they may be completely confined in specially constructed houses, with feeds cut and carried to them. These are the two extremes, but there is a huge range of feeding systems that fall between the two. The method by which goats are fed may also vary through the year. Goats may be restrained by tethering or housing for part of the year, perhaps while crops are in the field, and then allowed to graze freely after the crops have been harvested in the dry season.

It is important to know the main types of feed in the area in which you are working, and the characteristics of those feeds in terms of nutritional quality.

4.2.1 Natural bushes and trees

There are so many species that goats will browse in any particular grazing area or that may be collected by farmers for their goats that it is hard to characterise them. They may be green throughout the year, or may lose their leaves during some part of the year. Trees that are evergreen give goats an advantage over grazing animals during the dry season. When chemically analysed, they tend to show high protein levels and good digestibility; however, in reality,
much of the actual protein digestibility is reduced by the presence of anti-nutritional factors such as polyphenolic compounds, tannins for example, in the leaves. This is the reason why goats often perform worse than might be predicted from a simple chemical analysis of their feeds.

In the humid tropics, leaves from shrubs and trees can have a very high moisture content, which can actually depress intake. In the arid and semi-arid areas of the tropics at the end of the dry season, there is often a flush of growth on trees as the humidity rises before the onset of rains. Goats can take good advantage of this flush of green leaves, gaining weight before the start of the rains. They may then be able to start breeding earlier than sheep. In addition, the seed pods of native trees can be a valuable dry-season feed for goats. Pods may be eaten off the ground or shaken down by herders for their flocks. Pods of species such as Acacia tortilis or Acacia albida can be stored for later supplementary feeding.

4.2.2 Natural grasses

Natural grasses can be highly digestible when in a young stage of growth during the wet season, but tend to become stemmy and indigestible quickly during the dry season. Goats will eat grasses when there is no alternative. In pastoral areas the grass will quickly dry out and become what is known as standing hay. Although goats do not prefer this dry grass, they will eat it if there is nothing else available, so it can provide essential feed during the difficult dry season.

4.2.3 Crop weeds and thinnings

Weeds collected from cropland during the crop’s growing period, or grazed just after harvest, can be a valuable source of highly digestible feeds. Farmers in many countries have developed their own methods of using their growing crops for animal feed. Picking the leaves from growing maize or sorghum is one. Crops such as cassava, jackfruit, and banana can supply a high-quality feed for goats.

4.2.4 Crop residues

Crop residues include the stover of maize, sorghum, and millet, and the straws of rice, wheat, barley, oats, legumes, and oil crops. Generally they have a high fibre content, which makes them relatively indigestible to goats. Crop residues can be treated to make them more digestible, but they are basically unsuitable feeds for goats. The exception to this is the sweet-potato vine, which is a highly digestible and valuable feed.
4.2.5 Planted legumes

Legumes are planted to improve the quality of feed available to goats. They are normally rich in protein and highly digestible but, like natural trees, may have high levels of anti-nutritional factors, such as tannins, which reduce their digestibility.

4.2.6 Planted grasses

Grasses are normally planted to improve both the quality and quantity of the goat’s feed. If they are regularly cut or grazed, they can supply relatively high-quality feed which, with some supplementation, can be used as a basic diet.

4.2.7 Crop by-products

Crop by-products include rice or wheat bran, cassava chips, peanut cake, sunflower cake, linseed cake, and sugar-cane tops. These feeds can provide useful low-cost feed supplements for goats.

4.2.8 Crops

Crops such as maize, barley, oats, and sweet potatoes may be fed directly to goats in intensive systems of production.

4.3 The composition of feeds

It is important for extension staff and farmers to know the quality of different types of feeds and to know their characteristics and role in goat feeding. Feeds can be described at various levels of precision: simply as roughage or a supplement, for example. This may be useful in certain circumstances, but may not be accurate enough in others. At the other extreme, feeds can be analysed for the exact amount of protein in the feed or the precise amount of a mineral such as sodium, or the micro units of a vitamin. This level of accuracy is very high. In developed countries printed tables of feed analyses show the composition of feeds. This information is not available for many of the tropical feeds consumed by goats. However, it is useful to be able to read and understand printed tables of feed analyses. In order to do this, the composition of feed needs to be understood.

All food consists of the components shown in Figure 4.4. Food is first divided into water and dry matter (DM). The dry matter (DM) component provides all the nutrients necessary for life: energy, protein, vitamins, and minerals. It is on a dry-matter basis that foods are evaluated, because the quantity of water in
The composition of feeds

Food
- Water
- Energy
- Organic
- Protein
- Vitamins
- Dry Matter
- Carbohydrates (starch and sugars)
- Fibre (cellulose, lignin)
- Lipids
- Inorganic — Minerals

Figure 4.4 The main components of food

Food varies greatly according to food type, season, stage of growth, etc. So the starting point is to know the proportion of dry matter in a feed, because it is that part which contains the vital nutrients.

Carbohydrates
'Carbohydrate' is a general term which includes simple sugars such as glucose, more complex sugars such as sucrose, and highly complex substances such as starch, cellulose, and lignin. There are big differences in the ease with which each can be digested, and thus in the availability of the energy they contain. Glucose, sucrose, and starch can all be digested easily, and in the rumen cellulose can be degraded and digested. However, lignin is indigestible and unfortunately it is often combined with cellulose, making it hard for the goat to digest the cellulose part.

Lipids
The important lipids are fats and oils which are broken down to monoglycerides and fatty acids, absorbed by the goat, and used as a source of energy or stored as fat. Most tropical forages contain little fat. Any fat that is deposited in the body may be mobilised later, in the dry season for example, as a source of energy. Goats deposit less fat in the body than sheep.
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Protein and non-protein nitrogen
Proteins are vital to the goat: they form soft tissue, enzymes, hormones, antibodies, and genes. Proteins are made up of amino acids. Fortunately, the goat is able to make all the amino acids it requires out of proteins in its diet, and also from non-protein nitrogen compounds such as urea.

Vitamins
Vitamins are essential substances that are required in very small quantities. Some vitamins can be made by the goat itself (vitamin A, B complex, C, D, K), but others are required in the diet. A free-grazing goat should not have any problems obtaining most of its vitamin requirements for itself, but a stall-fed goat or a high-producing goat may face difficulty. Vitamin deficiencies can cause severe metabolic problems (see 6.5.9).

Minerals
Several minerals are essential for proper metabolism: calcium, phosphorus, sodium, chlorine, magnesium, potassium, sulphur, iron, iodine, copper, molybdenum, zinc, manganese, fluorine, cobalt, and selenium are all required in some quantities. Mineral deficiencies can cause metabolic problems. Goats observed to be eating soil are likely to be deficient in one or more minerals. Certain areas are well known for specific mineral deficiencies; for example, the Rift Valley in East Africa is known to be deficient in copper, zinc, manganese, and cobalt (see 6.5.9).

Water
Water is vital for life. It is used by the goat as a solvent in which nutrients are transported around the body and in which waste products are excreted. Many important chemical reactions take place in water. The evaporation of water is also used by the goat as a cooling method. Water evaporated from the skin, lungs, nostrils, and mouth helps to keep down body temperature. The goat obtains water from three sources: drinking water, water in food, and water released as a by-product of certain metabolic processes.

4.4 Methods of feed analysis

Feeds can be analysed to find out the amounts of the different nutrients they contain. Many feeds have been analysed in the past and there are standard feed-analysis tables for several thousand feeds, including many tropical feeds. By far the most common method of making a basic analysis of a feed is known as proximate analysis, which was developed over 100 years ago. In this method the food is broken down into the parts or fractions shown in Table 4.1.
Table 4.1 Feed components of proximate analysis

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>Water</td>
</tr>
<tr>
<td>Ash</td>
<td>Minerals</td>
</tr>
<tr>
<td>Crude Protein (CP)</td>
<td>Proteins, amino acids, B-vitamins</td>
</tr>
<tr>
<td>Ether Extract (EE)</td>
<td>Fats, oils, vitamins A, D, E, K</td>
</tr>
<tr>
<td>Crude Fibre (CF)</td>
<td>Cellulose, hemicellulose, lignin</td>
</tr>
<tr>
<td>Nitrogen-Free Extractives (NFE)</td>
<td>Cellulose, hemicellulose, lignin, sugars, tannins, water-soluble vitamins</td>
</tr>
</tbody>
</table>

There are problems in interpreting the results of proximate analysis. Important food components are split between two fractions; carbohydrates, for example, are split between the crude-fibre fraction and the nitrogen-free extractives fraction. The crude-fibre fraction should indicate the proportion of the feed that is indigestible; but it does not, because it contains both cellulose and hemicellulose, which can both be digested, depending how closely they are associated with lignin. Despite its weaknesses, this method of analysis is widely used in the tropics, and results from it are still the most commonly available sources of information on feeds. A typical feed-analysis table will look like Table 4.2.

Table 4.2 Proximate feed analysis for Leucaena leucocephala

<table>
<thead>
<tr>
<th>Plant part</th>
<th>Dry matter %</th>
<th>As % of dry matter</th>
<th>As % of dry matter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CP</td>
<td>CF</td>
</tr>
<tr>
<td>Fresh leaves</td>
<td>30.7</td>
<td>24.2</td>
<td>24.2</td>
</tr>
<tr>
<td>Pods</td>
<td>91.0</td>
<td>35.8</td>
<td>11.4</td>
</tr>
</tbody>
</table>

This table shows the amount of dry matter in the different parts of Leucaena leucocephala. It can be a helpful starting point when estimating how much dry matter a goat will receive from a feed. It also gives an indication of the amount of protein, but the crude-protein figure does not show how much of the protein is digestible by the goat. As a result, proximate-analysis results should be viewed as an initial, rather crude, guide to the potential value of a feed. The real value of the feed to the goat is, as we shall see, affected by many factors.
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Another problem with proximate-analysis results is that in the tropics goats tend to eat many different species of vegetation, either when out grazing and browsing, or when feed is cut and carried to goats. Goats tend to eat mixtures of feeds, with a wide range of nutritional characteristics. It is perhaps more practical to think about the general characteristics of the different feed types — grass, tree legumes, crop residues — rather than the specific characteristics of any particular species. This is discussed in 4.10.2.

Proximate analysis has been criticised for being imprecise and therefore unhelpful in guiding feeding. A better method of feed analysis is the Van Soest method, which has replaced proximate analysis in some laboratories. The Van Soest method divides the feed into different fractions from those employed in proximate analysis. The term Acid Detergent Fibre (ADF) may be seen in some tables; it is a good indicator of the indigestible fibre content of feeds. If fibre is indigestible, the amount of energy a goat can obtain from the feed is low.

Feed-analysis methods are improving all the time. However, it takes time for these new methods to be available in the developing world, and for tropical feeds to be evaluated using these new methods. In the mean time, goats must be fed, using any available information to best effect.

4.5 Digestion in the adult goat

It is now time to examine the goat’s digestive system and see how it can be manipulated to improve the nutrients it absorbs. The goat, like all ruminants, has a specialised series of organs, in which the huge quantity of fibrous feeds it eats is broken down into food components that it can absorb and actually use. This breaking down of foods is done for it by a collection of bacteria and protozoa, known as micro-organisms, to which the goat plays host. The goat provides the micro-organisms with a nice warm environment and a steady supply of food. The goat benefits from this arrangement, because it obtains food which has been partially broken down and which the goat itself can directly digest. The goat can also digest both dead and living micro-organisms when they pass out of the rumen, providing the goat with valuable nutrients. So when feeding a goat, it is important to think not just about the goat itself, but also how to make the micro-organisms active and able to multiply, by supplying them with the nutrients they need.

Feed enters the stomach through the mouth, where it is mixed with saliva. After passing down the oesophagus, it enters the rumen. The rumen is composed of four compartments: the omasum, abomasum, reticulum, and rumen proper. Once in the
Digestion in the adult goat

Rumen, the food is broken down by physical means through the movement of the rumen and during rumination, when the food is regurgitated and chewed again by the goat. This normally happens twice. The rumen is home to micro-organisms which secrete enzymes that act on the food and break it down. Carbohydrates (fibre, starch, and sugars) are converted into Volatile Fatty Acids (VFA) and methane. The VFAs can be absorbed through the rumen wall by the goat, while the methane is released through belching. During the process of breaking down food, a substantial amount of heat is also released. The goat has to get rid of this heat through panting, sweating, and simple convection. This heat source can be a huge advantage to it in a cold climate, but a burden in hot climates.

VFAs are the main direct source of energy for the goat's maintenance and growth. The goat is also able to convert them into milk. Three main types of VFA are produced in the rumen: acetic acid, propionic acid, and butyric acid. The proportions in which they are produced are determined by the type of feed consumed. For example, the balance between fibre and starch/sugars can have an effect on the quality and quantity of milk yield. Starch/sugars largely determine total milk production, while increasing fibre increases the fat content of milk. Feeding food rich in starch and sugars, such as sweet potatoes or whole grains, can have a dramatic effect on milk yield, but you have to careful. The break-down of starch and sugars happens very quickly, producing
large quantities of methane, which must be removed quickly if a bloating of the rumen is not to occur. Bloat can be fatal. Fibre is broken down much more slowly and helps to maintain efficient conditions for digestion in the rumen. Fibre should always be fed with foods such as grains.

Proteins are broken down by the micro-organisms in the rumen into peptides, amino acids, and ammonia. These are then used by the micro-organisms themselves, when they reproduce and multiply. Micro-organisms are continuously multiplying and dying. Living and dead microbes, when they move out of the rumen, constitute microbial protein, which together with amino acids is digested by the goat in the abomasum and the first part of the small intestine (Figure 4.6). It is important to understand that only proteins and amino acids which actually manage to reach the small intestine are of direct use to the goat. It is much more efficient for the goat to digest protein for itself in the small intestine, than to wait for the microbes to break down and digest a protein and convert it into microbial protein — which the goat then has to break down again for itself. Protein is often the scarcest, most expensive, component in the diet, so it is important to think about how to use most efficiently the protein that is available.

Urea can be absorbed directly by the goat, which recycles it through its saliva; or it may be converted into micro-organisms and then microbial protein for later use by the goat. This clever feature of rumen physiology means that microbial organisms in the rumen of the goat can be encouraged to develop, by feeding urea in the diet as a source of non-protein nitrogen. Non-protein nitrogen is usually a cheap source of nitrogen. The urea must be fed with a source of easily fermentable energy; molasses is commonly used, but others may serve this purpose. The urea might come from simple urea fertiliser. This is a feature that can be exploited to achieve cheap improvements in goat feeding.

![Figure 4.6 Protein digestion in the rumen and small intestine](image-url)
4.6 Manipulation of digestion in the rumen and small intestine

By now it should be clear that one option to improve the nutrition of goats is to manipulate the proportions of energy (fibre, starch, and sugars) and protein (amino acids and non-protein nitrogen), so that the rumen micro-organisms are well fed to do their job, and so that some protein escapes the rumen and provides a source of protein directly, and efficiently, to the goat through the small intestine. Protein that is broken down in the rumen is called Rumen Degradable Protein (RDP), which supplies a source of nitrogen to the microbes in the rumen. Protein that goes through the rumen and is digested in the small intestine is called Undegraded Dietary Protein (UDP), or simply 'by-pass protein'. Different feeds contain different proportions of RDP and UDP (Table 4.3).

Table 4.3 Degradability and by-passability of proteins from different feeds

<table>
<thead>
<tr>
<th>Food</th>
<th>Degradability</th>
<th>By-passability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass hay</td>
<td>0.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Soya bean meal</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Fish meal</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Blood meal</td>
<td>0.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Source: adapted from Chesworth (1992)

The amounts of RDP and UDP in any feed are measured by using the rumen bag technique. In this technique a hole, or fistula, is made in the rumen of an animal. The hole is kept open by a rubber ring with a plug, called a cannula. Samples of the feed to be investigated, which have already been analysed for protein content, are put into the rumen in small nylon bags with tiny holes in the bag. Enzymes from rumen micro-organisms digest the feed samples in virtually the same way that they would digest normal feed. The bags are suspended in the rumen and tied to the cannula, so they are not lost inside the rumen. In order to determine the simple digestibility of the feed, the samples should be left in the rumen for at least 24 hours. To estimate the amount of protein in the feed that will be degraded in the rumen, samples should be removed at 12, 24, 36, and 48 hours and analysed, as
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different proteins are degraded at different rates. The rumen bag technique gives a simple, quick, and useful assessment of the nutritive value of a feed in the rumen.

Unfortunately this technique has not been extensively used in goat-nutrition studies. Ideally, locally available feeds would be screened in this way to determine the proportions of UDP and RDP, and feeding strategies could be designed accordingly. Some of the more common tropical legumes are starting to be screened in this way and results from these studies are becoming more widely available. How can we use this knowledge to make sure the goat gets the best balance of nutrients?

The first question should be: does the current diet contain a source of carbohydrates that can be used easily by the rumen micro-organisms? This might be derived from grass or better sources such as bananas, banana peelings, or bread fruit. In addition to energy, the goat’s micro-organisms need a source of protein or non-protein nitrogen, so that they can multiply and build up a source of microbial protein for the goat. A diet that satisfies the rumen micro-organisms, and thus indirectly the goat, is likely to be sufficient for the basic needs of the goat. However, protein made by micro-organisms will not be enough if high levels of production are expected. In this case, a source of by-pass protein will be needed to supply higher levels of protein directly to the goat. This approach to feeding is shown in Figure 4.7.

![Figure 4.7 Rumen and small intestine feeding](image)

The principles of rumen manipulation are clear, but how can it be used in practice? It is important to know the characteristics of the current diet, identify their deficiencies, and try to rectify them as best you can.

For example, a typical diet of goats in the tropics has a high proportion of roughage, which is high in indigestible fibre and low...
Digestion in the kid

in protein. What can be done to improve this diet? The most important deficiencies here are protein and energy to enable micro-organisms to build themselves and be active to attack the fibrous feed and break it down. The micro-organisms will lack either RDP or non-protein nitrogen (NPN), which are required to enable them to grow, multiply, and break down the fibre in the diet. In this situation, a source of protein is required to supplement the diet. For example, feeding green-legume supplements to a diet consisting of crop residues, such as maize stovers, can improve the digestibility of the fibrous part of the diet and so speed up digestion in the rumen and allow the goat to eat more.

If, on the other hand, you have planted legumes to improve the protein levels, is there sufficient energy for the micro-organisms to use that protein effectively? If not, is there a source that farmers can afford to use? A common source is molasses, but other sources could be grains, bananas, or other fruit or fruit peelings.

If a goat is expected to produce a lot of milk or grow fast, feeding needs to be further refined to consider sources of by-pass protein. Many legumes contain high levels of by-pass protein.

It is clear that the rumen is a remarkable organ that can be manipulated to improve the supply of nutrients to the goat. Understanding the feeding habits of the goat and some of the functions of the rumen can improve the way in which goats are fed.

4.7 Digestion in the kid

The kid is born to drink milk and not to digest fibrous feeds, and so at birth it has only a partially developed rumen and reticulum. The kid digests milk with a well-developed abomasum. Food is directed to the abomasum through a tube formed after a reflex closure of the oesophageal groove, found in the wall of the rumen. This reflex closure ensures that milk goes directly to be digested in the abomasum and small intestine, and does not enter the rumen, where this valuable food would be broken down by microbes for themselves. The reflex is triggered by the suckling action of the kid. If it is weak and unable to suckle, digestive problems will be created by forcing milk down its oesophagus. If available, a feeding tube should be used to feed very weak kids and ensure that it receives adequate nutrients.

Soon after birth, the kid will start nibbling at grass and other vegetation. Although at this stage it is of little direct benefit to the animal, by eating such food the kid acquires the rumen micro-organisms it needs for an active rumen. Unfortunately this is when the kid is most vulnerable to infections acquired by indiscriminately eating contaminated food or drinking dirty water. Ideally the kid should be confined, and from the age of 2–3 weeks it should be given a small amount of highly digestible, clean feeds such as tree leaves or
green grass, which it can nibble and so acquire rumen microorganisms. As the quantity of dam's milk declines, the kid will want to eat, and be able to eat, more vegetative material. Kids are very vulnerable to malnutrition at the time of weaning, unless they are weaned on to high-quality feeds. The rumen is still poorly developed, so high-quality feeds such as sweet-potato vines, together with clean water, should be provided to ensure a good supply of nutrients to the kids through this critical period of weaning. In harsh environments, weaning can be a time of high mortality, particularly if it takes place in the dry season. Abrupt weaning is unnatural and should not be encouraged, because, unless high-quality feeds are provided, high mortality is likely to result.

4.8 Digestibility

Although the potential value of a food can be roughly determined by proximate analysis, the actual value of the food to a goat, what is digested and absorbed, cannot be calculated unless the digestibility of the food is known. Digested food is the part of the food that is consumed and not excreted as faeces. It is commonly expressed in terms of dry matter. There are two main methods of calculating digestibility, using live animals (in vivo) and in a laboratory (in vitro).

If a goat consumes 1.5 kg of DM as feed and excretes 0.3 kg DM, the apparent digestibility of the feed is:

\[
\frac{\text{Intake} - \text{Output}}{\text{Intake}} \times 100 = \frac{1.5 - 0.3}{1.5} \times 100 = 80\% \text{ digestibility}
\]

Coefficients for digestibility can be calculated for each fraction of the proximate analysis of dry matter. This method of calculating digestibility is not strictly accurate, as there are other losses of nutrients apart from the loss through faeces. Nutrients are lost in sweat and gases, for example, but these are very difficult to measure. Moreover, not all the material in faeces comes directly from the food just eaten; it could also have come from the body of the goat itself, in the form of dead microorganisms from the rumen, for example. Estimates of digestibility tend to lead to underestimates of true digestibility and are normally expressed as estimates of apparent digestibility.
The higher the digestibility of a food, the higher the quality of that food. Low-quality feeds that take a long time to be digested in the rumen will take up space and prevent more food from being consumed, reducing the total amount eaten. Feed that has a high dry-matter digestibility, such as young green grass or young leaves of leucaena, is high-quality food. Feeds such as older stemmy grass or rice straw have low digestibility, because there are high levels of lignin, making most of the cellulose indigestible to the goat.

The digestibility of any particular feed can vary according to many factors, including the following:

- **Stage of growth and part of plant**: the stage of growth of a forage species can affect its digestibility; similarly, the part of the plant, whether it is the growing point or older more lignified material, affects the quality of the feed.

- **Species of animal**: goats are thought to be more efficient at digesting fibrous feeds than sheep, particularly at low levels of crude protein.

- **Physical characteristics of the feed**: if the feed is chopped or ground, it may pass through the rumen so quickly that its digestibility is actually reduced.

- **Level of feeding**: an increase in the quantity of food can cause an increase in the rate of passage through the rumen and digestive system, so the food is exposed to digestive enzymes for a short period, reducing digestibility.

### 4.9 Feed in-take

The more food a goat eats, the better. This is true unless feed is very scarce and needs to be carefully rationed over a particular period, as in the dry season. The amount of food a goat eats will affect its health and production: the more the better. But eating is essentially a voluntary activity; it is hard to force a goat to eat something it does not want to eat! So it is important to understand the factors that affect the amount of food a goat eats, and how these influences can be manipulated so that the goat can be encouraged, and in some cases tricked, into eating as much as it can.

The amount of feed actually eaten by goats (the voluntary feed in-take) is possible to measure only in stall-fed goats. The amount eaten by grazing goats can only be guessed at. The quantity of feed consumed is determined by factors relating to the goat and factors relating to the feed, and the way the goat has access to that feed (Figure 4.8). This is true whether the goat is free-grazing or stall-fed, although obviously there is more scope, and need, for manipulation in stall feeding than if the goat is out grazing and allowed to express its natural preferences.
An objective of the farmer should be to 'trick' the goat into eating cheaper, lower-quality feeds such as crop residues, rather than the more attractive, more digestible, foods.

The taste, smell, and physical ease with which the goat can eat the feed are important. If it is contaminated, smells bad, tastes bad, and is difficult for the goat to reach, or the feed is presented low down on the ground so that it has to bend down to eat, then the goat will not eat very much. Ideally long coarse grasses or crop residues should be chopped. This can be done with a machete knife. If straw and stovers are fed, the goat will need access to clean water. These coarse feeds, with a high dry-matter content, need to soak up water in order for them to be digested.

If the feed is highly digestible, it will be degraded and absorbed quickly and pass through the goat's digestive system quickly. This in turn stimulates appetite, because the goat will quickly feel empty. Conversely, in some parts of the humid tropics, moisture content may be very high, in which case the goat may quickly fill up with watery feed and be unable to eat until it has excreted the excess water as urine.

If a feed is not liked by the goat, it will be very selective in what it eats. If a lot of feed is offered, the total amount eaten will be more than if it had only a small amount from which to select.
Mixing new feed with left-over feed, provided that it still smells and looks good, can trick the goat into thinking it is being offered a large quantity of new feed from which it can make its selection.

If the feed is liked, it is best to feed it little and often to avoid wastage. Goats are unable to be too fussy and selective in their feeding if they have only a small amount of feed; they will be forced to eat a higher proportion of feed on offer than they would have done if they had been offered a large quantity at one time.

In very hot and/or humid climates, the heat and humidity can reduce the amount that goats eat. In the process of digestion a great deal of heat is produced, which must be lost if the goat is not to overheat. Most of this heat is lost through sweating, which is less effective in humid environments. During the hottest part of the day goats may stop eating, not because they are full, but because they will have great difficulty in keeping their body temperatures down to a tolerable level if their rumens are very actively digesting feed and producing heat. In this situation goats will more actively feed at a cooler time of day, early in the morning and late in the evening. Allowing goats to go out grazing early in the morning and stay out late in the evening can significantly increase the amount eaten in hot environments.

In stall feeding, with many goats eating from the same feed rack, there needs to be enough space for all the goats to have easy access to the feed. Small, weak, sick goats may have trouble coping when there is competition for space and they have to fight over feed. In this case it is probably best to feed them separately.

4.10 The feed requirements of goats

Feed serves many different purposes, including the following.

- **Maintenance**: The normal activities of staying alive, breathing, blood circulation, digestive processes, etc., all require nutrients.

- **Reproduction**: Pregnancy and delivery make demands on the dam which have to be met from her feed, if she is not to lose weight. The foetus increases in size quickly during the last two months of gestation, drawing on the body reserves of the dam.

- **Growth**: Any growth requires nutrients; during the main period of growth between weaning and attaining the mature body weight, the goat requires large quantities of energy and protein.

- **Lactation**: Producing milk either for one or two kids or for human consumption requires high levels of energy and protein and good access to water.

- **Mohair production**: Energy and protein are both required for fibre production, but significant responses have been obtained
from protein supplements. However, a very high level of feeding does not produce a profitable response.

• **Extra activity:** Goats in pastoral systems have to be very active, particularly in the dry season, walking long distances searching for food. Goat flocks may walk 10–15 km each day, which requires a great deal of energy.

So far, we have considered the quality of the diet needed by a goat and ways of improving the balance of nutrients reaching the rumen and small intestine. In addition, particularly when stall-feeding goats and cutting and carrying feed to them, it is useful to have some estimate of the quantity of feed a goat needs. We need to convert the known nutritional needs of goats into quantities of real foods found on the farm.

How can we calculate the quantity of feed needed by a goat in order for it to meet its requirements?

### 4.10.1 How much dry matter?

At the simplest level, the goat has a basic requirement for a quantity of dry matter each day, regardless of its quality. To start with, this dry matter has to supply nutrients for maintenance, in order to keep the goat alive. Once the requirements for maintenance have been met, the goat will have other food needs: for growth, for lactation, etc. So it will have to eat more feed. This is where the problem arises with bulky low-quality feeds such as hay and crop residues, because — even when they are available in large quantities — the goat simply cannot eat enough of them to meet more than its basic requirement for maintenance. This is why it is important to try to improve the quality of the diet, so that the goat only has to eat smaller quantities of higher-quality foods.

In the tropics, goats eat about 2–3 per cent of their body weight in dry matter each day. The smaller meat-type goats (West African Dwarf, Small East African, Kambing Katjang) probably eat 2.5 per cent, while the larger, milk-type goats (Jamnapuri) eat about 3 per cent of their body weight. Dairy goats imported from temperate countries will need higher in-take rates, of about 4.5 per cent. In their home countries they might have in-takes as high as 6 per cent. For tropical goats, to be safe, it is probably best to slightly overestimate a goat’s needs and so use 3 per cent as a guide.

In order to know the actual weight of food which the goat should be fed, we now need to know the amount of dry matter in the food it is eating. If possible, take a sample and weigh it fresh, then dry it in an oven and calculate its dry-matter content for yourself. You may be able to refer to feed-analysis tables and calculate a rough average dry-matter content for the mixture of feeds which the goat eats (see Table 4.7). As a rough guide, most
The feed requirements of goats

tropical grasses contain about 25–30 per cent dry matter, depending on stage of growth. After calculating the amount of fresh feed needed, round up the figure to the nearest kilo or half kilo.

A sample calculation
An adult goat weighs 28 kg and will consume 3 per cent of its weight in dry matter per day.

\[
28 \times 0.03 = 0.84 \text{ kg dry matter per day}
\]
\[
0.84 \times 3.33 = 2.79 \text{ kg fresh feed required per day}
\]

So a 28 kg goat needs about 3 kg of feed per day.

How heavy is 3 kg? Find something that you know weighs 3 kg and try to remember how heavy this feels in your hand. As a guide, a newborn kid normally weighs about 3 kg.

Results from this calculation show the amount of feed the goat must actually eat after it has selected the bits it likes and left the rest. Allowance must be made for goats being very selective in what they eat. They need to be fed a lot more feed than 3 kg each, unless it is something they particularly like.

4.10.2 How much energy and protein?

It is possible to refine our estimates of the quantity needed and start to think about the quality of the diet, and whether it provides enough energy and protein to allow the goat to produce what we want it to.

The energy value of a feed is expressed in terms of Metabolisable Energy (ME), which is the energy actually available in the feed to be used for metabolism by the goat. There are several different energy units used in different countries. Most countries use the joule as their unit of measurement. ME requirements are quoted in megajoules (MJ). The amount of energy in a feed is expressed in MJ of ME per kg dry matter, because it is the dry matter that contains the energy. The amounts of energy required by the goat for different purposes are shown in Table 4.4.

Estimates of the requirements for protein are normally presented as digestible crude protein (DCP) requirements in grams per day. The DCP requirements for maintenance, growth, and pregnancy are shown in Table 4.5.

When considering feeding for milk production, remember that in addition to the considerable extra energy and protein which the doe requires, she will also need additional water, calcium, and phosphorus. If she does not have enough water, her production will be severely reduced. If the doe does not get sufficient calcium
Table 4.4 Total energy requirements (MJ ME per day) for goats

<table>
<thead>
<tr>
<th>Live-weight (kg)</th>
<th>Maintenance</th>
<th>Maintenance + some activity</th>
<th>Maintenance + a lot of activity</th>
<th>Maintenance + growth (50 g/day)</th>
<th>Maintenance + growth (100 g/day)</th>
<th>Maintenance + growth (150 g/day)</th>
<th>Maintenance + pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.3</td>
<td>2.8</td>
<td>3.2</td>
<td>4.0</td>
<td>5.8</td>
<td>7.5</td>
<td>5.1</td>
</tr>
<tr>
<td>15</td>
<td>3.2</td>
<td>3.8</td>
<td>4.4</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>6.9</td>
</tr>
<tr>
<td>20</td>
<td>3.9</td>
<td>4.7</td>
<td>5.5</td>
<td>5.5</td>
<td>7.3</td>
<td>9.0</td>
<td>8.5</td>
</tr>
<tr>
<td>25</td>
<td>4.6</td>
<td>5.5</td>
<td>6.5</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>10.0</td>
</tr>
<tr>
<td>30</td>
<td>5.3</td>
<td>6.4</td>
<td>7.4</td>
<td>6.8</td>
<td>8.6</td>
<td>10.3</td>
<td>11.5</td>
</tr>
<tr>
<td>35</td>
<td>5.9</td>
<td>7.1</td>
<td>8.3</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>13.0</td>
</tr>
<tr>
<td>40</td>
<td>6.6</td>
<td>7.9</td>
<td>9.2</td>
<td>8.0</td>
<td>9.8</td>
<td>11.6</td>
<td>14.3</td>
</tr>
<tr>
<td>45</td>
<td>7.2</td>
<td>8.6</td>
<td>10.1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>15.6</td>
</tr>
<tr>
<td>50</td>
<td>7.8</td>
<td>9.3</td>
<td>10.9</td>
<td>9.0</td>
<td>10.8</td>
<td>12.6</td>
<td>16.9</td>
</tr>
<tr>
<td>55</td>
<td>8.3</td>
<td>10.0</td>
<td>11.7</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>18.2</td>
</tr>
<tr>
<td>60</td>
<td>8.9</td>
<td>10.7</td>
<td>12.5</td>
<td>10.3</td>
<td>12.0</td>
<td>13.8</td>
<td>19.4</td>
</tr>
</tbody>
</table>

Source: adapted from Devendra and McLeroy (1982)

Table 4.5 Digestible crude protein requirements for maintenance and growth (grammes per day)

<table>
<thead>
<tr>
<th>Live-weight (kg)</th>
<th>Maintenance</th>
<th>Maintenance + 50g/day</th>
<th>Maintenance + 100g/day</th>
<th>Maintenance + 150g/day</th>
<th>Pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>15</td>
<td>25</td>
<td>35</td>
<td>45</td>
<td>30</td>
</tr>
<tr>
<td>20</td>
<td>26</td>
<td>36</td>
<td>46</td>
<td>56</td>
<td>50</td>
</tr>
<tr>
<td>30</td>
<td>35</td>
<td>45</td>
<td>55</td>
<td>65</td>
<td>67</td>
</tr>
<tr>
<td>40</td>
<td>43</td>
<td>53</td>
<td>63</td>
<td>73</td>
<td>83</td>
</tr>
<tr>
<td>50</td>
<td>51</td>
<td>61</td>
<td>71</td>
<td>81</td>
<td>99</td>
</tr>
<tr>
<td>60</td>
<td>59</td>
<td>69</td>
<td>79</td>
<td>89</td>
<td>113</td>
</tr>
</tbody>
</table>

Source: NRC (1981)
and phosphorus, she will have to draw on her body reserves and may develop metabolic disorders such as milk fever (see 6.5.9).

Typical nutritive values of common types of feed consumed by goats are shown in Table 4.7. A range of values is presented in the table, because each feed type contains several different feeds, of different nutritive values. The values in the table can be used as a starting point.

The amount of dry matter in grasses increases with age, while the amount of protein and the degree of digestibility decline. The concentration of energy in grass is not high. Crop residues have quite a high concentration of potential energy, but unfortunately most of this is in the crude-fibre fraction, which tends to be indigestible. It is hard for animals to eat enough bulky straws and stovers to obtain sufficient energy for maintenance; crop residues are also very low in protein (2-4 per cent), which also tends to be relatively indigestible.

### Table 4.7 General nutritive value of common feed types

<table>
<thead>
<tr>
<th>Type of feed</th>
<th>Dry matter (%)</th>
<th>Crude protein (%)</th>
<th>Digestibility of protein (%)</th>
<th>Crude fibre (%)</th>
<th>ME (MJ per kg of DM)</th>
<th>Energy concentration (MJ ME/kg feed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young</td>
<td>15</td>
<td>15-20</td>
<td>50-70</td>
<td>20-35</td>
<td>8-10</td>
<td>1.2</td>
</tr>
<tr>
<td>Old</td>
<td>25</td>
<td>5-10</td>
<td>40-50</td>
<td>25-35</td>
<td>8-9</td>
<td>2.0</td>
</tr>
<tr>
<td>Crop residues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straw</td>
<td>80-90</td>
<td>2-4</td>
<td>20-30</td>
<td>30-40</td>
<td>7-8</td>
<td>5.6</td>
</tr>
<tr>
<td>Stover</td>
<td>80-90</td>
<td>2-4</td>
<td>20-30</td>
<td>30-40</td>
<td>7-8</td>
<td>5.6</td>
</tr>
<tr>
<td>Green leaves (fresh)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legumes</td>
<td>20-30</td>
<td>20-30</td>
<td>60-70</td>
<td>15-25</td>
<td>10-12</td>
<td>2.0</td>
</tr>
<tr>
<td>Non-legumes</td>
<td>20-30</td>
<td>15-25</td>
<td>40-60</td>
<td>20-30</td>
<td>7-12</td>
<td>1.4</td>
</tr>
<tr>
<td>Grains and oil cakes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legumes</td>
<td>90</td>
<td>40-50</td>
<td>70-80</td>
<td>5-10</td>
<td>10-12</td>
<td>9.0</td>
</tr>
<tr>
<td>Cereal</td>
<td>—</td>
<td>10-15</td>
<td>70-80</td>
<td>2-10</td>
<td>13</td>
<td>10.8</td>
</tr>
<tr>
<td>Roots</td>
<td>30-50</td>
<td>2-8</td>
<td>40-70</td>
<td>1-10</td>
<td>12-13</td>
<td>3.6</td>
</tr>
<tr>
<td>By-products</td>
<td>70-90</td>
<td>5-30</td>
<td>40-70</td>
<td>2-15</td>
<td>10-13</td>
<td>7.0</td>
</tr>
</tbody>
</table>

### Table 4.6 Energy and protein requirements for one kg milk

<table>
<thead>
<tr>
<th>Breed</th>
<th>ME (MJ/day)</th>
<th>DCP (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical</td>
<td>5.0</td>
<td>45</td>
</tr>
<tr>
<td>Temperate</td>
<td>5.2</td>
<td>50</td>
</tr>
</tbody>
</table>

(ME = metabolisable energy; MJ = megajoules; DCP = digestible crude protein)
Tree leaves vary tremendously in quality. Leguminous trees tend to have high protein contents. However, much of this protein is associated with anti-nutritional compounds such as tannin. Much tree-legume protein is 'protected' from digestion in the rumen and may be classified as 'by-pass protein'. Tree legumes should ideally be fed with another source of rumen-degradable protein for best effect. Non-leguminous trees include a wide range of tree species. They tend to have lower levels of protein than tree legumes.

Oil cakes made from legumes such as peanut cake or soya-bean meal tend to be high in both fats and proteins. The high fat content gives them a high concentration of energy. They can make a useful protein and energy supplement. Other feeds in this category include fishmeal, linseed meal, and coconut cake. They tend to be high in fats.

Cereal grains such as maize, barley, oats, sorghum, and rice have the highest concentration of energy, mainly in the form of starch with some sugars. Protein content can be as high as 16 per cent in oats, which appear to be particularly liked by goats. Most cereals should be regarded predominantly as a source of energy. Some form of treatment to the grain increases its digestibility. This might include coarse grinding or rolling.

Root crops are low in protein, but high in energy. The concentration of energy is not as high as in grains, because roots tend to have a high moisture content. Roots, unless very small in size, should be chopped to improve intake.

By-products of food processing include a huge variety of potential feeds, including brans left over from milling, brewer's grain, sago chips, and molasses. Dry matter tends to be high and protein tends to be low.

How can this information be used to calculate the food needs of a growing goat?

A sample calculation
To calculate the amount of feed needed to supply enough energy and protein to a growing goat, let us assume that a 20 kg goat is growing at 50 g per day. From a simple calculation of dry-matter in-take, 3 per cent liveweight, it needs 0.6 kg dry matter. If it is eating grass of 20 per cent DM, it must eat at least 3.0 kg of fresh grass. The goat needs 5.5 MJ ME per day for maintenance and growth of 50 g per day (see Table 4.4).

How can this be supplied from different feeds? Using data from Table 4.7, we see that 5.5 MJ ME could come from any one of the feeds shown in Table 4.8. But remember that the goat would find it hard to physically consume forage of more than 3 per cent of its body weight, which in this case is 0.6 kg of feed (DM). It is possible to feed energy-rich cereals or oil seed cakes in very small quantities, while much more grass or tree leaves have
The feed requirements of goats

Table 4.8 Alternative sources of the energy requirement

<table>
<thead>
<tr>
<th>Feed type</th>
<th>FW</th>
<th>DM</th>
<th>DMI (% LW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young grass</td>
<td>4.6</td>
<td>0.7</td>
<td>3.5!</td>
</tr>
<tr>
<td>Old grass</td>
<td>2.7</td>
<td>0.7</td>
<td>3.5!</td>
</tr>
<tr>
<td>Straw</td>
<td>1.0</td>
<td>0.8</td>
<td>4.0!</td>
</tr>
<tr>
<td>Tree legume leaves</td>
<td>2.7</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Tree leaves</td>
<td>3.9</td>
<td>0.8</td>
<td>4.0!</td>
</tr>
<tr>
<td>Legume cake</td>
<td>0.6</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Cereal</td>
<td>0.5</td>
<td>0.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Roots</td>
<td>1.5</td>
<td>0.4</td>
<td>2.0</td>
</tr>
</tbody>
</table>

(DM = dry matter; DMI = dry-matter intake; LW = liveweight, FW = freshweight)

to be eaten. Straw appears as quite an energy-rich feed, but in reality is high in fibre, so much of the energy is indigestible and cannot be used. But more importantly, in order to grow at this rate, a goat needs more than energy: it also needs protein.

From Table 4.5 we see that the goat also needs 36 g of digestible crude protein. Table 4.9 shows how this protein can be supplied from these same feeds. Compare the quantities of the same feed needed to supply enough energy and protein to the goat. Which are the best-balanced feeds? Which are the worst-balanced that would need to be supplemented to achieve growth of 50 g/day?

Table 4.9 Alternative sources of the protein requirement

<table>
<thead>
<tr>
<th>Feed type</th>
<th>FW</th>
<th>DM</th>
<th>DMI (% LW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young grass</td>
<td>3.2</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Old grass</td>
<td>7.2</td>
<td>1.8</td>
<td>9.0!</td>
</tr>
<tr>
<td>Straw</td>
<td>11.2</td>
<td>9.0</td>
<td>45.0!!!</td>
</tr>
<tr>
<td>Tree legume leaves</td>
<td>1.2</td>
<td>0.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Tree leaves</td>
<td>3.0</td>
<td>0.6</td>
<td>3.0</td>
</tr>
<tr>
<td>Legume cake</td>
<td>0.1</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Cereal</td>
<td>0.5</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Roots</td>
<td>13.5</td>
<td>4/5</td>
<td>22.5!!!</td>
</tr>
</tbody>
</table>
Here it can be seen that straw would not after all be a good feed for a growing goat! Nor would old grass, tree leaves, or root crops. The best 'balanced' feeds for growth are young grass, tree-legume leaves, or an oil-seed cake. However, from the calculation of dry-matter in-take, it is clear that this goat would have difficulty eating enough young grass or tree legumes to achieve this high rate of growth. In reality it is hard to achieve even the modest growth of 50 g/day without feeding an energy and protein supplement, either a cereal or an oil cake.

This calculation shows how these tables can provide a rough, but practical, guide to feeding goats. Where possible, use feed analyses of specific feeds; but, if they are not available, using these simple tables can show the sorts of level and types of feed that goats need in order to live and produce to meet the needs of their owners. In reality, goats are fed a mixture of feeds. Section 5.5 shows how to calculate the right mixture of different feeds. The challenge is to match the needs of the goats with the feeds that are available, and where possible to improve the supply of the sorts of feed that can make up for any deficiencies.

4.10.3 How much water?

Goats in the tropics are second only to the camel among domestic animals in the efficiency with which they use water. However, this efficiency should not lead us to overlook their needs, and particularly the needs of lactating goats. In the wet season, or in the humid tropics, goats may eat forage composed of 70–80 per cent water. In this case, they may not need to drink water at all. However, most feed in the tropics has a lower content of moisture, and goats will need to be given water in addition to their feed. Coarse, fibrous feeds will need to be accompanied by quite a lot of water, if the goat is going to be able to digest them at all. The feed needs to have absorbed water in the rumen, if the rumen micro-organisms are going to be able to attack it at all. Ideally goats would have constant access to a supply of clean water, but in most parts of the tropics people themselves do not have such access, so it is too much to expect goats to have it.

The amount of water a goat needs depends on its breed, the climate, the type of food eaten, and the purpose for which the goat needs the water: for milk, growth, fibre, etc. Tropical breeds kept in arid and semi-arid areas may be able to drink only once every two–four days in the dry season. They have a great ability to use their rumen for water-storage and reduce water-loss in urine and faeces. Temperate breeds of goats do not have this ability to the same extent and may need twice as much water as a tropical breed in the same environment.

It is normally recommended that goats consume four times as much water as dry matter, i.e. 4 kg water for 1 kg DM feed, but
they may need more than this at higher temperatures. Remember that milk is 90 per cent water, so if a goat is producing one litre of milk, she will need at least an extra litre to replace it. Normally it is recommended that an allowance of 1.3 litres of water per litre of milk produced is given to lactating goats.

Finally
Feeding animals is partly a science, but it is also an art. Close observation of the performance and behaviour of goats can lead to better feeding. It is very important that farmers closely observe their goats to look at their health and general well-being, their performance (milk yield, etc.), and preferences. The guidelines set out above may be used, but should be modified after observing the behaviour and performance of particular goats.

Further reading

Agriculture and Food Research Council (AFRC) (1993) Energy and Protein Requirements of Ruminants, AFRC Technical Committee on Responses to Nutrients, Wallingford, UK: CAB International