



Goat keeping

Useful management practices for smallholders



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Foreword

Goats are important in many regions because they provide people with valuable food and or income. They supply animal protein in the form of milk and meat for consumption or sale. This is particularly important for families of low-income farmers and the landless that do not have the resources to keep a cow and cannot afford to purchase meat and milk.

This Agrodok gives information about the main aspects of goat farming in the tropics such as feeding, breeding, health care, reproduction and recording. It is meant for farmers with some education and some knowledge about goats. The second target group are technicians like extension and animal production officers, who as advisers can assist smallholders planning to start or improve goat production. The main focus is on relatively small scale production.

The booklet is the product of intensive cooperation between the three authors, who together have over 100 years of experience in livestock production in Africa, Asia, Europe and Latin America. We sincerely thank everyone who helped in its preparation, including the peer readers Willem Brinckman, Peter Hofs and Ralph Roothaert. The Chapter about Health, diseases and parasites has been revised, but is basically the same as in the previous edition. Special thanks go to Barbera Oranje who did the drawings.

While we hope this Agrodok will help farmers make their goat production more profitable, we are grateful for any comments, suggestions, additions and criticism.

The authors
Deventer, 2015

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1 Introduction - the importance of goat keeping

The great popularity of goats can be explained by their adaptability to a great variety of climates and the many functions and production purposes for which they are kept.

Goats are especially important in the (sub) tropical countries: according to recent FAO statistics the world goat population was almost 862 million head, of which 840 million head (98%) in these regions. There is no specific data about the number of milk goats and meat goats. Goats are particularly important in (Sub Sahara) Africa, the Mediterranean region and the Indian Sub-continent (India, Pakistan and Bangladesh), where you find the largest concentration of goats. According to recent data the goat population in the (sub) tropics increased by over 100% since 1980.

1.1 The importance of goats

Goats are of high importance because of the many functions they provide. The rearing of goats provides a small but nevertheless significant supply of animal protein in the form of meat and milk. This is particular important for families of low-income farmers and the landless that do not have the resources to keep a cow and cannot afford to purchase meat and milk.

Access to land for smallholders is becoming increasingly precarious due to fragmentation, poor implementation of land policies, and irregular sales and allocations.

Advantages of keeping goats, especially for smallholders:

- Goats serve as an inflation proof bank account which can be used when cash is required, and the kids are the interest of that account, thus spreading of risks.
- They know wide climatic adaptation, by browsing not competing for roughage with other ruminants and making efficient use of fibrous feeds.
- They can function as the “poor man’s cow” for smallholder families.
- Goats have a small size: relatively cheap to purchase, and suitable for home slaughter, sacrifice and gifts.
- There are fewer cultural restrictions on ownership and handling of goats by women and youth than for cattle or other large livestock.
- There is a fast reproductive rate: early maturing, short kidding interval, twins common, quick returns on investments, quick building up of flock.
- There are no no religious taboos.

Disadvantages are:

- Goats are inquisitive, need proper fencing and/or stabling or active herding to prevent crop damage.
- Formal goat market chains are less developed or less accessible than other livestock value chains.
- Small value makes formal credit systems uneconomical or impossible.
- Goats are susceptible to respiratory diseases and internal parasites.

1.2 Farming Systems

Depending on the ecological zone and the production purpose, different farming- and management systems can be distinguished: intensive, tethering, semi-intensive and extensive.

Intensive system or zero grazing

This system is more suitable for improved (dairy) goats in the humid and sub-humid eco-zones. In the intensive system the goats are confined to a shed and the roughage is provided by a “cut and carry” system. In an intensive management system the sheds are usually separated in a single pen for the buck and possible single pens or group pens for the does. Kids are kept in group pens, which are usually separated by sex (for more detailed information see Chapter 2, Housing). In this system controlled mating is practiced. Roughage (grass/fodder crops) can be cultivated and/or collected from roadsides and fodder- and other trees. Fodder banks of tree legumes can be established and properly handled crop residues can be utilized.

Advantages of the system are:

- It keeps goats from damaging crops and prevents traffic accidents.
- Goats can make efficient use of crop residues, kitchen waste/peelings and agricultural by-products.
- It is well suited to productive animals, exotic breeds and their crosses which are more susceptible to diseases.
- It reduces burden of internal and external parasites.
- It allows for close observation (heat detection, health, feed/water availability).

Tethering

Tethering describes a system in which goats are kept in a shed during nighttime, whereas during daytime they are tethered in the vicinity of the house, along the roadside or on public grounds. Tethering of goats is practical only for very small herds. Only adults are tethered, while young kids are often let loose. Often the sexes are not separated in the shed, so mating is uncontrolled. Feed and water should be provided in the shed.

Two methods are common:

1. Tied to a peg. Goats, sometimes 1 to 3 together, are tied to a peg by a rope of 3-5 meters length. By shifting the peg or choosing a different

- tree or post, the goats are offered a fresh grazing/browsing area (see figure 1).
2. Tied to a ring on a wire between 2 pegs. A rope of about 2-3m long is tied to a ring which slides on a wire about 3-5 meters long (see figure 2).

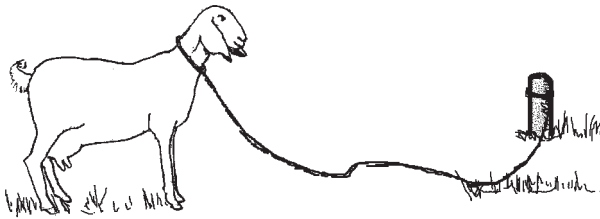


Figure 1: Goat tied to a peg

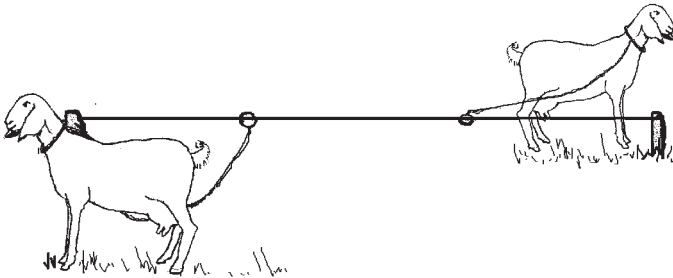


Figure 2: Goat tied to a ring on a wire

Care has to be taken that the goats do not get entangled or even strangled and that the goats will not be attacked by dogs/predators. It is advised to provide a small area with fresh grazing and/or browsing each time. To prevent trampling of the grass the pegs should be shifted 2 to 3 times per day to offer fresh grazing. The tethering area must offer some shade, especially when the tethering period is prolonged and includes the hottest part of the day (between 11 am and 4 pm).

Semi-intensive system

In the semi-intensive system the confinement of goats is restricted to night-time and part of the day. Animals are let out for grazing during a restricted part of the day, usually 3-5 hours supervised by a herdsman. The advantage of this system is that it gives the goats the opportunity to supplement their diet and do some selective feeding to overcome dietary deficiencies. During the confinement, stall feeding is practiced. Very often young kids are left behind in the shed, corral or yard. Separation of the sexes is rarely practiced, uncontrolled mating is common. An option within this system is grazing the goats in fenced paddocks.

Extensive production system

Extensive goat husbandry systems usually involve larger numbers of animals. The goats graze and browse large areas of land that are usually marginal in nature and/or are unsuitable for other agricultural use. The system is more common in the arid and semi-arid climates. Extensive systems are common for meat and hair goats, but are rarely used for dairy goats, although some goats may be milked temporarily for family supply. A very low level of unpaid family labour represents the main input, although for large herds paid labour may be employed. Little management is practiced except to let them graze in day time and to lock them up for the night in night pens or yards. Breeding is uncontrolled. The goats are watered during the day at streams, lakes and ponds or water is provided from wells. After the harvest of crops the animals can feed on the residues and weeds left in the field. Sometimes mixed herds of sheep and goats graze together. The droppings in the night yards can be collected as manure.

2 Housing

Goats are kept in varying climates. Within each climatic zone many more, smaller zones can be distinguished which can differ greatly. Some are dry others are wet. Sometimes this is combined with heat, or in other places with cold. The conditions can be stable but are often also extremely variable. In short, each region has its own requirements for the housing of animals.

2.1 Reasons for housing goats

Climate control

An important function of housing goats is to protect their health. Just like with many other (domestic) animals, goats cannot take damp conditions nor draughts well. With good housing, a waterproof roof and draught-proof walls to keep out damp and draughts, you will avoid goats becoming sick. Goats are well protected against the cold by their coat of hair.

Extreme heat, on the other hand, bothers them. A goat will search for shade by itself if it gets too hot. If no natural shade is available you must provide a shelter. Roofing materials like thatch or coconut leaves are preferred as

they absorb the heat from the sun and keep the inside of the shed cooler. Corrugated iron sheets can become very hot from the radiation of the sun, leading to a higher temperature in the shed.

Especially pregnant goats, nursing goats and their young are suffering under unfavorable climatic conditions, therefore provide them with protection. Always keep an eye on their breeding, health and feeding as these aspects will be affected when housing is not adequate.

Observation

Good housing makes it easier to keep an eye on your goats. You can detect and act more easily when the goats come into heat, during mating, pregnancy and kidding when the goats are kept in a pen than if they wander around freely outside.

Disease symptoms such as diarrhoea and coughing can be noticed earlier when the goats are kept housed or penned. It makes a difference whether you house the goats individually or as a group. Within a group an inactive goat, possibly due to a disease, will be noticed sooner. A good shed has a quarantine area where you can separate goats which are probably sick.

An advantage of housing is that you can give each animal individual attention and better feed. For example, you can control the feeding of pregnant or nursing animals or a weakened, sick goat. Furthermore, there are certain housing systems, which make the milking of goats easier.

Safety

Preventing of theft can be another reason for building a shed. It goes almost without saying that the shed must be solidly built and should stand close to the house or compound. An alert watchdog (and geese) can also help. Furthermore, protection against stray dogs, predators, snakes or vampires may be necessary in certain regions.

Especially in densely cultivated areas, a watchful eye must be kept on goats to prevent them from damaging crops. Sometimes this is only necessary for a certain part of the year, when the crops are in the field.

Collection of manure

By keeping goats inside, you can collect their droppings and use these as a fertilizer. Keep collected droppings protected from rain and sunshine when storing as to maintain the fertilizer value.

2.2 Aspects to consider for housing

There is no blueprint for housing, choose for yourself the form which best suits your situation. Build the shed in such a way that the goats can easily stay, eat and rest there. Make sure that you can work there with pleasure. Also look for good examples in the region.

Invest in quality

The investment in good housing may seem high at the time you calculate the cost of building, but it is low in comparison to the other costs. A good shed will last a long time and reduce the cost for feed, labour, dead or stolen animals and caring for sick animals. So do not save on the cost of the building of the shed and good equipment without careful thought.

Individual or group housing

In general, goats are housed as a group because this is less labour intensive for the goat keeper and the building costs of the stable are lower. The goat is a true herd animal and prefers group housing. In order to avoid unrest the size of the herd must not be too large. If the goats do not graze, a surface area of one and a half to two square meters of floor space is needed per adult goat. If they do graze one square meter per goat is sufficient.

Temporary and permanent housing

A distinction must be made between temporary and permanent housing of goats. In temporary housing, the goats are kept penned only at night or during part of the day, the rest of the time they are grazing. If you keep

them permanently penned or housed, you must take complete care of the supply of water and feed.

Temporary housing has the advantages that the shed can be smaller and that you do not have to provide all the feed and water yourself. This is only possible if there is enough pasture and/or browsing in the area. In densely populated areas with a lot of crop production, pasture is often limited and you are usually forced to keep your goats permanently housed.

In both temporary and permanent housing, the goats are kept within an enclosure. Enclosures can be made of stone piles, stakes, thorns or wire fencing. Planting a hedge of quick-growing shrubs or trees, such as *Leucaena*, *Calliandra* or *Glyricidia*, creates a possibility for fencing. Since goats eagerly eat such bushes, you will initially have to protect the young plants until they are large enough to resist being browsed. Local thorn bushes or cactuses are also suitable for making living hedges. You can put a triangle around the neck of a goat that regularly breaks through the fences (see figure 3).

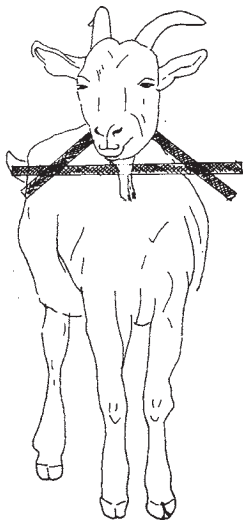


Figure 3: Goat with triangle

2.3 Building sheds

A first decision is where to locate the shed. It must be near the home so that you can easily keep an eye on the goats.

Positioning the shed

Depending on the climate, the positioning of the shed can be important. By placing the length of the shed east - west, you can prevent the sun from heating up the stall too much. If, on the other hand, you want the sun to shine on the floor so that the floor dries up and parasites die, it is better to build the shed along a north - south axis. This is only relevant for ground level sheds, not for stilted sheds with slatted floors.

The roof is also very important for good temperature regulation. A wide overhang/eave prevents too much sun shining on the floor. In cooler cli-

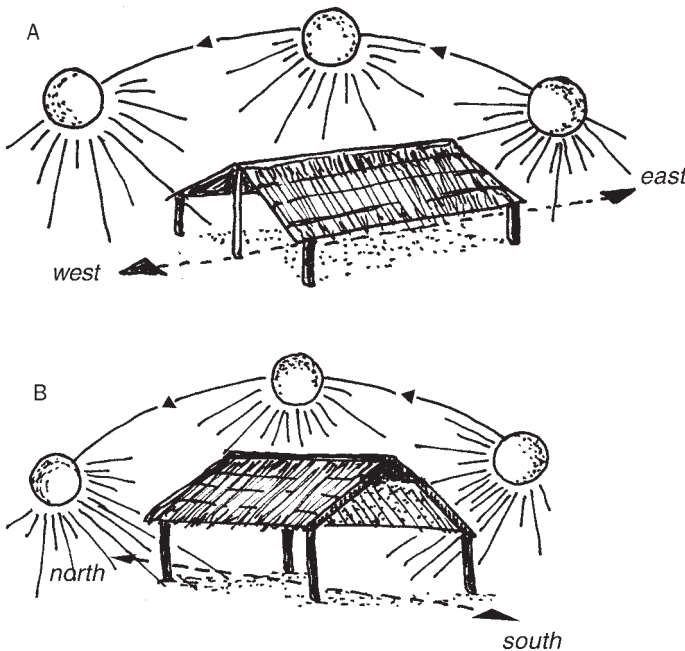


Figure 4: Positioning of the shed - A: shed placed at east-west axis; B: shed placed at north south axes

mates, sunlight may actually be desirable to warm up the stall. In that case, a large surface area of the roof facing south (in the northern hemisphere) or facing north (southern hemisphere) is useful so that the roof which is warmed also warms up the shed (see figure 4).

Ventilation

In warm climates the shed will heat up due to sunshine. Also goats emit heat when digesting their feed. If the animals cannot get rid of that heat because the surrounding temperature is too high, they eat less and therefore produce less. Ventilation is also essential to prevent respiratory diseases to which goats are very susceptible. Make the shed sufficiently high and be sure there are openings for ventilation in the roof or walls.

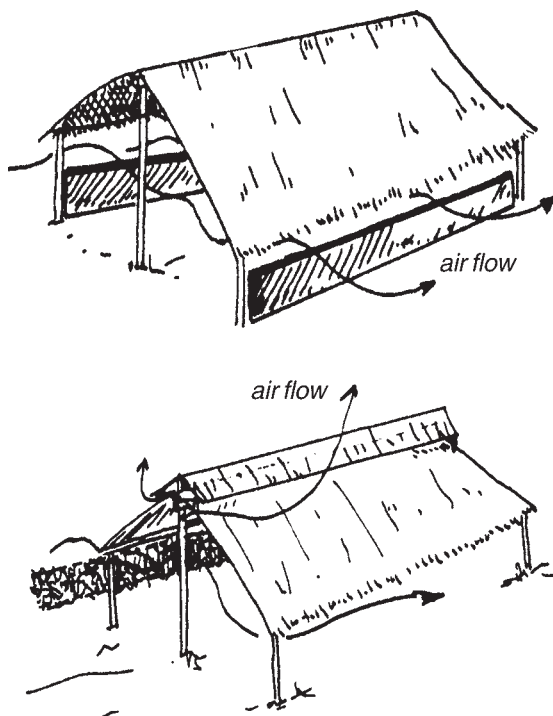


Figure 5: Ventilation in shed

In warmer climates, where the stalls are fairly open, a low wall (of about 1.20meter) on the side the wind comes from is sufficient. A hedge can also fulfil this function (see figure 5).

In wet climates, it is important that the roof is waterproof and has a large enough overhang to prevent rain from blowing in. Clues for a suitable way of achieving this can be found in the way the roofs of local houses are constructed.

The floor

The floor of the stall must be easy to keep clean and should remain dry. A damp and dirty floor stimulates the development of all kinds of germs and worms. The goats also get wet and dirty, cool down too much, are susceptible to diseases and produce poorly.

- If the foundation consists of sand, urine is absorbed well. Daily collection of the droppings will keep the floor clean and allows the urine to drain into the sand.
- A hard clay or loam floor has the advantage that it is easily cleaned.
- An elevated ground level floor sloping to the sides will prevent rain water from entering the floor and allows urine to drain to the outside.
- In the wet tropics, an elevated slatted floor using bamboo or wooden slats is advised (see figure 6).

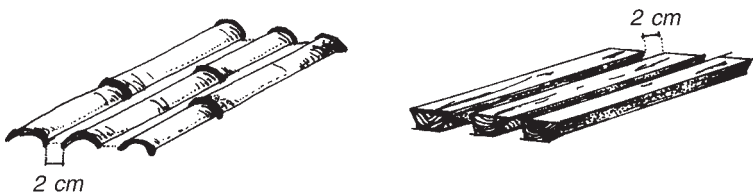


Figure 6: Two types of a slatted floor: bamboo (left) and wooden slats

On a solid ground level floor you can put bedding or litter materials in order to keep the animals clean and to provide good insulation in a cold climate or season. Any type of dry organic material can be used as bedding; it can be straw, weeds, dry grass or leaves, sawdust, etc. Bedding soaks up urine

and droppings, it is advisable to add enough new bedding regularly so that all urine is soaked up and the bedding stays clean and dry. Be careful that you do not bring in ticks with the bedding materials. The mixture of bedding, urine and droppings piles up and has to be removed after some time, e.g. when it is 50 cm high. This mixture makes very good compost which can be used on the home garden or field. On the bedding the hooves of the animals may grow very rapidly. These must therefore be cut back regularly (see Appendix 2: Hoof care).

2.4 Requirements in the shed

In all housing systems the required roofed space per adult is about 1-1.5m², depending on the breed. Some separate pens of about 2x2 m are advised for kidding and sick animals. In order to prevent spreading diseases in case of bacterial or viral infection to other animals, a separate pen can be considered outside the shed. In larger herds it is advised to keep the kids for 1-3 months in the shed when the herd is grazing. In controlled breeding systems a separate pen is required for the buck.

To facilitate easier milking, goats are placed on a platform with a feeding rack in front so you can constrain the animal and make the animal feel comfortable and at ease.

Supply of feed and water in the house is important. Also for systems that rely (partly) on grazing it is advised to supply water, feed and salt/minerals in the shed during the night. Providing the feed in a rack/manger or in a net hanging from the wall or roof prevents the feed from being trampled upon and becoming dirty and contaminated with droppings and urine.

Water troughs have to be placed in the shade and be elevated to prevent contamination with droppings and urine.

2.5 Housing systems

Basically there are two housing systems, the elevated ground level shed recommended in the more extensive systems and the stilted goat shed

which is most common in the intensive and semi intensive system; however, (“closed”) ground level sheds are also practiced.

The elevated ground level shed

In this system there is a thatch roof for shade in a fenced night yard provided for the goats. This system is more suitable for arid and semi-arid areas climates where goats graze in the day time and is advised for extensive systems with meat production as the main purpose. It is simple to build and not costly. However, it requires a protective enclosure. The shed floor is raised with earth about 30 cm above the ground level and slightly sloped (see figure 7). In this way water and urine can run off at the same time preventing rainwater to enter the shaded floor, so the floor stays dry. As goats like to play, some rocks or tree trunks can be placed in the yard.

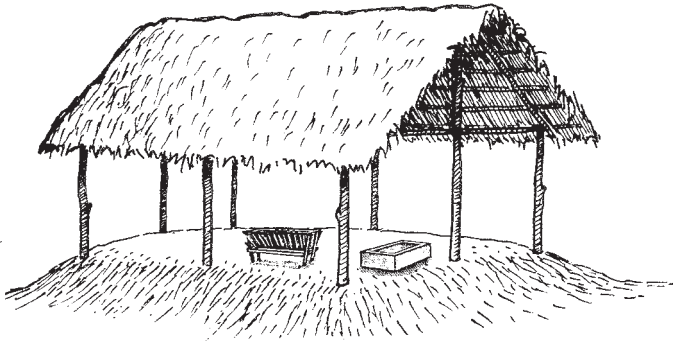


Figure 7: Elevated ground level shed

The stilted goat shed

As the stilted goats shed requires quite some investment, the system is more applicable for intensive milk- and meat production systems and certainly advised for the humid and semi-humid climates. The slatted floor, with about 1.5 cm space between the slats, is elevated about 70-90 cm above the ground. Goats reach the shed by climbing a wooden ramp.

The slatted floor is preferably constructed from wood as bamboo may cause wounds to the feet. The shed protects the goats from rain, strong winds

and excessive sunshine. Infection stress and problems with internal and external parasites are strongly reduced and the goats are protected from dogs and wild animals. The shed is easy to clean and manure can be efficiently collected. The walls should be built with slats with a width of about 5 cm all around. At the lower part of the wall the slats should be about 5 to 7.5cm apart, at the higher part of the wall (1 m and above) between 20 and 30 cm apart.

The walls can be constructed from wood or bamboo. This allows for efficient and sufficient ventilation, essential to prevent respiratory diseases. The eaves of the thatched roof should be long enough to prevent rain from coming in the shed during strong and windy rain showers. Division of compartments in the shed are made for the milking goats, the kids and the buck. If possible there should be a separate pen for sick animals away from the main shed.

A similar shed can be built on ground level, but the hygiene of the floor has to be considered. Daily cleaning or a system of piling up the bedding is necessary.

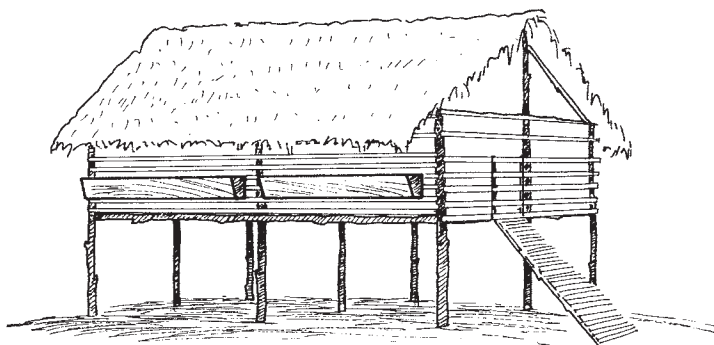


Figure 8: Stilted goat shed

2.6 Requirements of housing

- When building sheds it is well to heed the saying: Look before you leap. Go and look at sheds of other goat keepers in the surroundings

and try to understand why things were built the way they are and using those specific materials. Ask for advice when choosing local materials. Realise that most knowledge you need is available in your area.

- The kidding of goats can best take place in a separate pen, so that the young kids are born in clean, dry, draught free and safe surroundings.
- When raising young animals, it may sometimes be necessary to keep them apart during the first three months of their life. In larger herds, there is a danger that small animals will be trampled by the larger ones or that they will lose their mothers. When grazing on difficult or dangerous terrain, kids can get hurt or lost. Make a clean, dry and draught-free pen in the stall.
- Both the sick-bay as well as the pens for kidding and raising must be kept extra clean.

Milking facilities

To facilitate milking, goats are placed on a platform so that you have easy access to the udder. With the help of a feeding rack you can constrain them and at the same time feed them. To get clean milk, hygiene is very important.

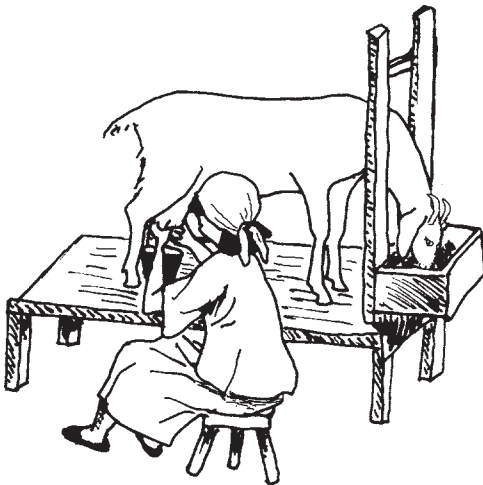


Figure 9: Platform for milking with feeding rack

Feeding and drinking facilities

In each housing system, the supply of water and feed is of great importance. Spreading feed on the floor causes it to be trampled, get dirty and reduces the quality of the feed.

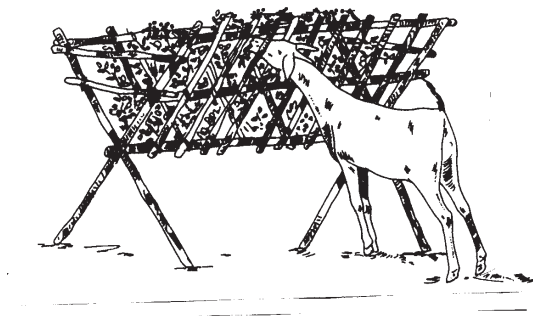


Figure 10: Goat eating from a manger (Adapted from: Peacock, 1996)

There is great usefulness for a manger. The goats eat their fodder from the manger with raised heads, without the feed touching the floor. Materials which can be used include wooden poles or planks, metal rods, harmonica netting (mesh width 5 x 5 cm) . Make sure that green fodder has been partially dried, wet feed is poorly digested. It is also possible to hang roughages like twigs and branches on a rope, or grass/hay in a net.

When giving high quality roughages or concentrates some animals can miss out on it. Especially since you usually hand it out in small quantities and the strongest goats take everything for themselves. You can avoid this with a feeding rack. With such a rack each animal has its own feeding spot (see figure 11).

When the goats have placed their heads through the rack, you lower the plank so that the goats are fastened. The plank is secured with a chock. In an alternative construction you use a plank which you slide into place over the heads of the goats.

A feeding trough which lies above the level of the stall floor makes cleaning easier. A raised placement also prevents goats from standing in it or their droppings and/or urine getting in it. This is also true for the placement of watering troughs. Provide clean drinking water as needed for the animals

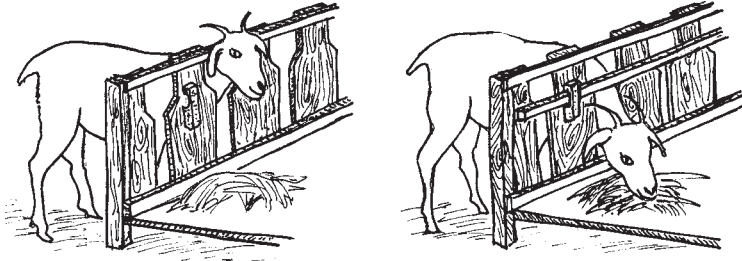


Figure 11: Feeding rack with beam

3 Goat feeding

Goats are essentially browsers, not grazers. This means that they try to select carefully what they eat and can feed themselves with trees and bushes in places where there is not enough to eat for cattle and sheep. Their tongue and flexible upper lips make it easy for them to pick leaves and small branches from between thorns. Due to their selective browsing capacities they consume in general more protein than cows or sheep.

Some people say goats will eat everything, even plastic! This is not true; they are very selective in their eating habits if they have the opportunity. So to let them eat as much as possible and to get maximum production, you have to offer them a considerable amount of varieties of feeds. This implies also that you have to throw away many leftovers when stable feeding. Under grazing conditions, give them enough time to browse and select the most palatable (parts of) plants.

Especially the pregnant and lactating nannies need extra feeding. During the last month of pregnancy they need twice as much energy and protein as normal. This is also needed when they produce a good amount of milk. If they do not get enough quality feed, they will use body reserves, lose

weight and drop their milk production. Thereafter, it will be difficult to restore milk production again.

3.1 What do goats need

The characteristics of the nutritional requirements of goats are similar to those of other ruminants. Like cattle and sheep, they need water, energy, protein, fibre, minerals and vitamins to live, grow, reproduce and produce milk. Even when an animal is not producing, it needs energy and protein to stay alive, breath, walk and ruminate. The basic needs, to maintain a stable condition, are called “maintenance requirements”. When the requirements for maintenance of an animal are not covered, it will lose weight, not come in heat and might fall ill. The maintenance requirements of an animal depend on its body weight. A heavy animal needs more energy and protein for maintenance than an animal with a lower weight. If the farmer wants goats to grow, reproduce or produce milk, he or she needs to provide additional energy and protein. These are called the “production requirements”. For production, proportionally more protein is needed than for maintenance.

The amount of feed a goat needs depends on:

- its weight, the heavier it is the more feed it needs;
- the type and level of production: meat, milk and reproduction require additional nutrients. The more milk is produced, the quicker the growth and the more advanced in pregnancy, the more feed the animal needs;
- the level of activity: grazing animals spend more energy and need extra feed compared to housed animals.

The need of nutrients for individual goats can be calculated in a “scientific way”. However, this is not very practical for smallholders nor for goat keeping under extensive conditions for the following reasons:

- The nutritional value of the feedstuffs offered is not easily known and may vary considerably.
- It is very difficult to determine which parts and how much of the feedstuffs are consumed by individual animals as goats are selective eaters.

Nevertheless, in Appendix 1 daily requirements and the nutritional value of some feedstuffs are given. The nutrients required by the goats are described here below.

Water

Water is extremely important. Although goats are probably among the domestic animals that can survive longest without water (camels can do better), more than three days without drinking water may cause their death. For milk producing or pregnant does, a daily supply of sufficient clean drinking water is essential. A non-producing goat will need about 5 - 6 litres of drinking water or 10 % of its body weight per day. Of course this depends on the climate and water content of the feeds as well. In arid climates and when consuming mostly hays and straws, the goats need more drinking water. For each litre of milk produced, the doe needs another additional 4 - 5 litres of water. When it is getting hot, goats need more water to cool their body. If they do not drink enough, they will also eat less and their production will go down. Therefore, provide drinking water once a day at a regular time so they can get accustomed to the routine. The cooler the water is, the more they will eat. So try to provide them with as much of and as cool and clean water as possible, although this may be difficult to do in remote areas.

Energy

Goats need energy to maintain their body, to move, to grow and to produce milk and kids. Main sources of energy in feedstuffs are carbohydrates (starch, sugars, digestible fibres) and fats. Feedstuffs rich in energy are concentrates (cereals, oil seeds and their by-products, molasses) and good roughages. Straws and mature grasses have a low energy and protein content and are slowly digested because they contain much indigestible fibre.

Proteins

Proteins are essential building materials for the animal body and are an important component of milk and meat. Goats need protein for maintenance of their body, for growing and especially to produce milk and kids. When

the milk production of a goat is higher, proportionally she will need more protein.

Important sources of proteins are young grass, leguminous roughages (e.g. Alfalfa, Desmodium) and oilseeds and their cakes. For goats, thin branches and leaves of leguminous fodder trees and of browse plants, like *Leucaena* can be a good source of protein. Cereals, cassava meal, molasses and mature stemmy roughages are low in protein.

Minerals

Goats need minerals and common salt in small amounts. When they are fed a variety of feeds, they often get all the minerals they need. However, during grazing rangeland or feeding on limited amounts of concentrates, mineral deficiencies may occur. Minerals such as salt, calcium and phosphorus are important for the proper functioning of the life processes. A shortage is only noticed after the animal has used its reserves. The deficiency has already existed for some time by then. A lack of minerals will lead to a decreasing appetite, declining fertility, a dull coat and poor growth. The animal licks at all kinds of objects and even chews them, in an attempt to satisfy its mineral needs.

Goat milk is rich in minerals so lactating does require relatively high amounts of minerals per day so provide them with salt and a mineral mix. Try to buy a mineral mix of good quality and give the animals free access to this mix so they can eat as much as they want. Be aware, if animals are not accustomed to minerals, get them adapted to the mix gradually. Otherwise they may overeat and as a result get ill. It is best to offer a mineral mix and common salt separately.

Other needs

If goats have the possibility to consume different types of feeds during grazing or in the stable, it is normally not necessary to pay special attention to vitamins.

As goats are ruminants, they need a certain amount of fibre (structure) in their ration. This is seldom a problem in the tropics. However, it may be a problem in the humid tropics during the rainy season when forages are very green and contain a lot of water. Under such conditions, providing some hay, stover or branches of trees is recommended. In the arid tropics, most roughage contains too much fibre and this will limit the amount the animals will eat of it as it is slowly digested.

3.2 Intake

The intake capacity of goats means the amount of feed they can eat per day which is limited. Intake varies according to the individual, the feed's particularities and the physiological status of the individual goat, such as: is it growing, pregnant or lactating. On average, intake of dry matter per day is around 3 % of body weight but can be somewhat higher for high yielding dairy goats. Within the dry matter consumed, the goat has to satisfy its needs of energy, protein, vitamins and minerals.

Goats are ruminants, which means that they chew their food two times. They have four stomachs: rumen, reticulum, omasum and abomasum. Thanks to such a digestive system, in which micro-organisms help to digest the fibres, goats are able to utilize coarse roughages fairly well. Through this system they are able to convert plant protein into animal protein.

To get good intake, the first step is to provide sufficient roughage of good quality. These can be grasses, legumes, crop residues, prunings from fruit trees, etc. For high production levels, concentrates may have to be provided, especially when the roughage is of poor quality.

3.3 Grasses

Grasses are common forage for goats in all production systems. There are many different species and varieties of grasses. Their feeding value varies considerably, especially due to the kind of grass, its growth stage and season, see table 1.

Table 1: Quality of grass

Good grass	Poor grass
Young	Mature
Rainy season	Dry season
Dark green colour	Light green or yellow colour
Juicy (about 20% DM)	Dry (more than 40% DM)
Mainly leaves	Many stems
Not flowering	Flowering
Very tasty, high intake	Less tasty, low intake
Often fertilized	Not fertilized
High protein and energy	Low protein, average energy
Covers maintenance and requirements for moderate production	Does not cover maintenance requirements

Natural grasses

Many small farmers use local grasses cut along the roadsides or by grazing with a tether. This resource of roughage is not very reliable since neighbours may also use it. Furthermore, it can easily be contaminated by traffic exhaust, excrements, parasites and garbage. Plots with local grasses are often less productive than land with well managed improved forages. Once land becomes limited and milk production more economically rewarding, intensification through planting, sowing and fertilization of improved grasses and fodder crops becomes more attractive.

The choice whether improved pasture or forage is best under your conditions depends on the environment, climate, soil and the farming situation but also the choice of variety within the species can be very important. Consult the extension officer and neighbours about their experiences.

Elephant grass

Quite often, Elephant (Napier) grass is recommended for zero-grazing because it is high yielding, it boosts milk production if cut at the right height and maintained well by fertilization and weed control, it remains green

during the dry season and can withstand drought better than most grasses and it is suitable for cutting.



Figure 12: Young Elephant grass is a good roughage but when old and stemmy it is poor feed

The optimal cutting interval in the rainy season is about 6-8 weeks at a grass length of 60-90 cm. Feeding too tall Elephant grass of more than 1.20 m will result in lower production as the quality of the grass becomes poor. If there is sufficient forage, only the tops can be cut and fed, while the

lower part may be left in the field for mulching or used as compost. Due to its thick stem, Elephant grass is not suitable for haymaking and grazing.

Big goats like Saanen and Toggenburg eat at least 3 % of their body weight in dry matter. This is some 10 kg of fresh grass per day. Smaller breeds may eat about 5 kg. For high milk production, supply the grass liberally to allow goats to eat sufficiently and allow some selection and left-over. Fed on grass alone, a goat of 50 kg can produce about 1 kg of milk daily. Young Elephant grass will allow a production of about 1.5 kg. Old grass may provide only feed for maintenance. Chop the grass into pieces of 5-10 cm to reduce losses.

To maintain the good feeding value of roughages at a young stage, grasses can be conserved as hay or silage. Haymaking can be feasible on small farms, but silage making is only practical for large intensive goat farms and is therefore not described in this booklet. Conservation implies additional efforts and when not carried out adequately, the feeding value will decrease sharply during the conservation process. Conservation is useful in areas where there is abundant forage during the rainy season. Haymaking consists of drying grass or legumes in the field and thereafter storing it in a dry place. To reduce losses, it is important to keep the drying period in the field as short as possible and legumes have to be handled carefully to reduce losses of leaves.

3.4 Crop residues and by-products

Crop residues can be used for feeding goats. However, they are often not very nutritious and can be mouldy or contaminated by pesticides. Sometimes they can be used by grazing the goats on recently harvested fields, but it may also be possible to collect the crop residues and store them for use during the dry season. Especially haulms from beans, groundnuts and peas can be quite good food for goats. Straws from cereals are rather poor feeds whereas wheat, barley and oats straw are better than rice straw but they still need to be supplemented for production. Green maize and sorghum stovers are quite good feeds, but when they become dry and brown

their feeding value is low. It is best to strip the leaves and cob leaves and feed those. This also gives easy access to the grain so that it will not age and lose nutritional value.

For sustained high animal production, forage availability throughout the year is important. On mixed farms, crop residues from grains (maize, sorghum), legumes (beans, cowpea), fruits (banana) or roots and vines (sweet potato) can be important to cover gaps in the supply of grass.

Sugarcane tops have only a fair feeding value but are important as they become available in huge amounts during the dry season in certain areas.

Residues left over from the food and beverages industry can be valuable feeds for goats. They include molasses, brewer's grain, rice polishing, wheat bran and by-products from the oil-producing industry like soybean cake, coconut cake, cottonseed cake. Also citrus pulp, pineapple waste or bananas can be used as feed. The goat keeper has to be alert as occasionally regional by-products can be available which are good and cheap feed for goats. Even a small amount of by-products can have a substantial effect on the production of the goats. Molasses or cane-syrup is rich in sugar (=energy) and minerals like calcium and potassium. Furthermore, it can improve the taste when mixed with other feeds like cottonseed cake but it reduces the digestibility of roughage somewhat.

In conclusion, although some crop residues and by-products have a low feeding value, they can be very useful to overcome feed shortages. Often a lot of information about their use is available locally. If their protein content is low, supplementation with protein rich concentrates is recommended to enable the goats to produce well.

3.5 Leguminous forages

Legumes are quite common and are good roughages. Alfalfa (Lucerne), berseem and clovers are widely used and are excellent feeds for milk producing goats. They can fix nitrogen from the air by nodules on their roots;

therefore they contain more protein than the grasses. Legumes also improve soil fertility. Seeds of legumes often have to be inoculated before sowing. It is quite difficult to maintain a good mixture of grass and legumes in the tropics. However, the mixture of the legume *Desmodium* with Elephant grass is an example of a rather successful combination under favourable conditions. Most frequently, legumes are grown on a separate plot called a “protein bank” to supply extra protein to the ration when needed. Those protein banks are cut for zero grazing or grazed only for a limited time each day by animals which need it most, for example the goats producing milk or during the dry season.

Fodder trees or any other tree or bush which is not poisonous can provide valuable additional nutrients for goats. They can be planted on field and farm borders and provide good fodder during the dry season. The thin branches with leaves and sometimes with fruits (pods) are hung in the stable or yard so the goats can reach them but not spoil them. They can also be cut and left for feeding in the grazing areas. Farmers and pastoralists from the area often have a wealth of knowledge about local trees and shrubs that provide good fodder. Examples are:

- legume trees like *Leucaena*, *Gliricidia*, *Acacia*, *Sesbania* and *Erythrina*;
- fruit trees like apple, pear, peach, jack tree, mulberry, mango, cashew;
- other trees like *Ficus* or willows;
- other plants like hibiscus (ornamental) and banana plants including green bananas.

Some legumes contain substances which may cause illness or cause bloating if the animals eat too much of it. For example *Leucaena* should not exceed more than 30% of the daily feed.

Important aspects of forage utilization

Land has to be prepared well before planting or sowing forages: weed and bush control, ploughing, harrowing and sometimes ridging. Fast establishment during the rainy season is recommended and helps to control weeds.

Improved forages only produce well if they are fertilized with manure and/or fertilizers. In particular nitrogen is important for grasses, phosphorus for legumes and potassium for both. Without manure or fertilization grass production will decrease fast.

Grazing or cutting management of grass should be adapted to the species. Look for a good compromise between quantity (low cutting frequency) and quality (harvesting at a young stage), see table 2.

Table 2: Effect of cutting frequency on DM yield en Crude Protein (CP) content of Elephant grass with adequate rainfall and fertilizer application.

Cutting frequency	DM yield kg/ha/year	CP %
4 weeks	9000	11.0
6 weeks	15500	8.2
8 weeks	19000	6.4

Using the grass which is harvested early and not too young will increase yield, stimulate re-growth and help to control weeds. So less frequent cutting results in higher DM yields but the protein content decreases.

3.6 Concentrates

Concentrates or supplements have a high dry matter content which is rich in energy and/or protein. Examples are cereals or their by-products and oil seeds or their cakes. Commercial concentrates consist of several of those ingredients and often include extra minerals too.

As indicated before, to increase production levels, concentrates are required. However, as many goats are kept in remote areas and/or by relatively poor people, commercial concentrates are often not available or are too costly. Under those circumstances, the goats have to do without concentrate or these have to be composed with locally available ingredients. A basic concentrate consists of energy rich components combined with one or more protein rich components plus salt and minerals.

An example of a home-made concentrate is the following:

- | | |
|---|--------|
| • rice bran (or wheat bran, maize bran, rice polishing, etc.) | 5 kg |
| • ground maize (or wheat, sorghum, etc.) | 3 kg |
| • coconut meal (or cottonseed cake, soybean meal, etc.) | 1 kg |
| • common salt | 0.1 kg |
| • ground shells, rock salts or commercial mineral mix | 0.1 kg |

3.7 Practical feeding

The following aspects should be taken into account:

- Goats do not like spoiled, mouldy or dirty feeds. Feeds fallen on the floor and trampled on are not readily consumed. So again, offer them a variety of clean and fresh feeds every day, in such a way that it cannot get spoiled or wasted. Offer the feeds in racks or troughs to allow the animal easy access without having to fight over the feeds. A rope or a net can also be used as feeding trough rack.
- For high production of milk or quick growth, high quality feeds in generous quantities are needed. Especially for high production of milk, the provision of concentrates and minerals is necessary; only roughage is not sufficient. Where possible, half a kg of concentrates for each kg of milk produced should be provided.

Intensive goat keeping

When a limited number of goats are kept in an intensive way for the production of milk, individual attention to the animals can be given. They can be taken out for grazing and tethered or fenced in a small paddock. When tethering, they should have sufficient roughage available. Movement to fresh spot two or three times a day is necessary. Feeding of concentrates for high productive milking goats is recommended and when the goats are housed during the night, they should also have feed (forages) available.

Under zero grazing conditions, roughage should be offered liberally in feed racks or in bunches hung from the roof to prevent spoilage as much as possible. Concentrates and minerals should be offered in separate feed trunks.

Also on bigger specialized goat milk producing farms, goats are frequently kept indoors. On such farms, the goats are kept in group pens for up to 50 animals. Feeding, based on good quality roughages like fresh grass or hay, is combined with additional concentrates. Permanent provision of drinking water and minerals is common practice on such commercial farms.

Grazing of larger goat herds

Goats are notorious for breaking through fences, to keep them in as well as out. So goat-proof fences are difficult and relatively expensive to construct. That is the reason most goats are herded. When in the field, they not only consume grasses but also herbs, shrubs and leaves, branches and bark of trees. Although this is positive from a nutritional point of view, it increases the risks of overgrazing, bio-degradation and erosion. Under those conditions, careful herding of the goats becomes very important to minimize the permanent damage to the vegetation and to prevent the grazing of cultivated crops.

Possible improvements

- The protein quality of the grazing land can be improved by introducing more nutritious grasses or legumes such as Desmodium. Also fodder trees can be planted and leguminous trees like Leucaena should be the priority. Their leaves and pods contain more protein and the leaves which are left on the ground supply nitrogen to the grass. Legume trees can fix nitrogen from the air. Fodder trees can be planted in rows or be used as live fences. In some cases, rows of legume trees are grown in the fields with Napier grass. Some fodder trees or multi-purpose trees can be left in the field to grow big and provide shade and the branches can be lopped and fed to the goats when needed.
- Some supplementation with crop or industrial by-products reduces weight losses during the dry season and stimulates the production of milk and kids.
- Avoid degradation of the vegetation by giving it a rest to recover after grazing.

3.8 Final recommendations

Goats in the stable should always have plenty of clean roughage/forage available so they can select the best parts. Left-overs can be used for composting or mulching.

If concentrates are available, provide those to weaned kids, the best milk producing goats and pregnant goats, but do not let the pregnant does grow too fat.

Minerals and salt are essential for all goats, whether stable-fed or free-grazing.

Goats should have access to drinking water at least once a day, dairy goats in the stable preferably on a permanent basis.

To increase the production of the goats, the following measures can be taken:

- Increase the consumption of forages by offering large amounts so animals have choices.
- Chop the grass and fodders coarsely to increase intake.
- Improve the quality of the ration: better forages or more concentrates.
- Provide a good roof for protection against sun and rain.
- Provide adequate drinking water, best is ad lib. under the roof.
- Provide sufficient minerals and salt.
- Prevent digestive disorders: do not switch too abruptly between feeds, do it gradually.
- Control internal and external parasites.
- Vaccinate against prevalent diseases.
- Select for high yielding animals.

4 Health, diseases and parasites

Just as in human health care, the rule applies “It is better to prevent than to cure”. It saves a lot of money and problems if goats are and remain healthy, because of good care:

- Provide adequate, well ventilated housing and clean the housing frequently, maintain a strict hygiene.
- Provide enough proper feed and water. Insufficient or incorrect feeding weakens the animals.
- Allow sufficient time for grazing. Avoid that the goats graze too often successively on the same pasture because this increases the contamination of the pasture with parasites like worms and ticks.

It is impossible to remain completely free of diseases and parasites. Your goats may come in contact with other animals or their excrement during grazing. Therefore, the most commonly occurring diseases and parasites are mentioned.

In Annex 2 you will find an explanation about hoof care. Checking and caring for the hooves is a regular job to prevent infections and walking difficulties.

The time, money and effort you invest in keeping your animals healthy through preventive care repay itself in a more productive herd.

Should there be a veterinarian or veterinary assistant in your area, consult that person whenever in doubt about preventive measures or health problems. He/she has more knowledge, skills and experience diagnosing diseases and often has access to medicines and facilities such as a laboratory. It is better to pay for a consult than losing money because of sick or dead animals.

4.1 A healthy goat

You can recognize a healthy animal by its behaviour, appearance and the correct functioning of its body processes:

- Goats are generally energetic animals and walk at a good pace. They are curious and have a bright look in their eyes. They have a good appetite and chew their cud when they have eaten enough.
- Their coat should be smooth and shiny, and the animal should not be skinny.
- If you look more closely at the appearance, start with the mucus membranes. These are good indicators of the general condition. A healthy animal has pink mucus membranes of the eye, mouth, nose and vulva.
- One of the most important life functions is the good consumption and digestion of feed and water. A good intake can be judged on the basis of the eating habits of the goat. A healthy goat also ruminates regularly while resting. A healthy goat with a good digestion produces dung of many round and firm droppings.
- Other important body functions are good blood circulation, breathing and urination, related with heart, lung and kidney processes. The heart-beat of a healthy resting animal is, respectively for a young, yearling and mature goat, 110-120, 80-120 and 70-80 times a minute. The heart-beat is raised by high production levels or in highly pregnant animals. Calm breathing is a sign of good functioning of the lungs: for young, mature and old animals respectively 12-20, 12-15 and 9-12 times a minute. The proper functioning of the kidneys is seen by clear, yellow urine

- A practical indicator of the health is the body temperature. By holding a thermometer for at least one minute in the anus of an animal, its temperature can be measured. Young goats have a higher temperature, up to 39.0 °C = 102.2 °F. Mature goats have a temperature of about 38.5 °C (101.3 °F). During the first few hours after eating goats can have a higher body temperature.
- The milk production, finally, is a characteristic life function of female goats. A healthy udder is soft and supple. Just before kidding it can swell up and harden without in fact being infected. The milk should have a homogenous consistency and must not smell strange. A decrease in the daily milk production is a sign that something is wrong. However, when a female goat goes into heat, its milk production may become somewhat less.

4.2 Diagnosis of a sick goat

A sick goat can be noticed when it differs in behaviour from the rest of the herd. Especially for acute (quickly developing) diseases, the symptoms are often obvious. The sick animal may lose weight rapidly. Quick intervention is necessary because acute often implies fast declining body condition and there is a high risk that you will lose your goat. If the disease is contagious, other animals in the herd are in danger too, so immediate action is required. With chronic (long-term) diseases the symptoms are not as obvious. Sometimes you will only notice that a goat is losing weight and produces less. Such diseases are therefore difficult to detect. By comparing with other goats within the herd and of neighbouring herds, you should be able to see whether or not you are dealing with a chronic disease. Keeping up-to-date records will help you to detect health problems too.

4.3 Infectious diseases

If you suspect that your animals suffer from an infectious disease, it is highly recommended to consult a veterinarian or other expert to give a correct diagnosis and suggest proper treatment.

Peste des petits ruminants (PPR; Small ruminants pest)

This disease, which resembles rinderpest, is caused by a virus and is found especially in Africa. Infection takes place by inhaling the virus which is released together with the nasal mucus of sick animals.

- Symptoms: after an incubation period of 4-5 days, 6-8 days of high fever follow. Lesions of tissue in the mouth, inflammation of the mucous membranes with excessive nasal mucus production, diarrhoea. High death rate within one week. Secondary lung infections may occur. Especially affects young animals.
- Prevention: vaccination is effective. Limit the movement of sick animals to prevent the disease from spreading.
- Treatment: Treatment of sick animals is very costly but possible in an early phase. Killing them is better. Secondary lung infection can be treated with medicines.

Contagious caprine pleuro-pneumonia (CCPP)

This form of contagious lung infection, is caused by a small, one-celled organism called *Mycoplasma mycoides*. It spreads by drops of nasal mucus. When kept permanently housed, the entire herd can be infected. Death rate can rise to 100%.

- Symptoms: rapid breathing with coughing. The animal groans when breathing out and usually secretes much nasal fluid. High fever.
- Prevention: a well ventilated shed; vaccination.
- Treatment: arsenic preparations and antibiotics.

Haemorrhagic septicaemia

Caused also by *Pasteurella* bacteria. All ruminants can fall victim to it, especially in humid lowland tropics or at the start of the wet season. Spreads through drops of nasal mucus. After having passed through a number of victims, the bacteria gets more aggressive. Stressed animals are more susceptible. Death rate: 80-90 % of the animals infected.

- Symptoms: incubation period 2 days, after that high fever, no appetite, rapid breathing, strong saliva production, rapidly developing eye infection, mucus membranes red and swollen.

If the disease is less acute, symptoms are: infection of throat and

tongue. Suffocation is possible. Bloody diarrhoea in later phase of the disease.

- Prevention: preventive vaccinations are available, to be given 1-2 months before the hot/wet season when the disease manifests itself strongly.
- Treatment: with sulphonamides and/or antibiotics.

Foot-and-mouth disease

This viral disease affects, as the name implies, mouth and hooves but also the udder and the teats of goats. The disease is transmitted by direct contact, via contaminated food, by vaginal discharge, by placenta, through the wind or by birds.

- Symptoms: incubation time 3-8 days, followed by excessive saliva production and frothing at the mouth. Small blisters are formed in the mouth and on the legs. The goat has difficulty walking and limits its own movements. Animals do not die from the disease, but their production of milk and growth decreases or stops during the illness.
- Prevention: vaccination is possible. If only isolated groups of goats are affected, slaughtering those animals is an effective way of limiting further spreading of the disease. Quarantine of sick animals, disinfection of all animals (foot baths) and prohibiting transport of animals at district or provincial level may limit the outbreak.
- Treatment: keep them eating by offering tasty soft feeds.

Anthrax

Anthrax is sporadically found among goats. Cattle, sheep, pigs, horses and humans are susceptible to this disease. The organism causing the disease is the bacterium *Bacillus anthracis*. Transmission via water and food which is contaminated with blood and excrement.

- Symptoms: incubation time 1-3 days or more. Initial symptoms are very high fever and sudden death. After death, blood flows from the body openings.
- Prevention: annual vaccination campaigns are very effective. To avoid the spreading of the disease, carcasses of dead animals must be completely burnt or buried in unslaked lime (quicklime) 2 meters

underground! This is to prevent possible spreading via scavengers (also dogs). Do not open the body, autopsy to determine cause of death should be done only by highly specialized personnel because of high risk of infection. It is safer to assume that the sudden death of animals was caused by Anthrax (if there is reason to suspect this) and to dispose of the cadaver as described. Consumption of this meat is very dangerous!

- Treatment: Antibiotics (curative) are effective, but due to the rapid development of the disease, treatment is often too late.

Ecthyma or Orf

Especially in the humid tropics, this disease often occurs among goats but is usually not very serious. The disease is highly contagious through direct contact.

- Symptoms: Sores in and around the lips. Due to sores growing and merging, at a certain moment goats can no longer eat and rapidly get very thin.
- Prevention: provide adequate housing. Vaccination is recommended for young animals in infected pens, by brushing the vaccine on a small, lightly scarified skin area.
- Treatment: isolation of contaminated animals and frequent disinfection of the sores. Provide some tasty and “soft” feeds. Kids after weaning very vulnerable, especially when in the phase of changing their front teeth.

Brucellosis

This form of infectious abortion frequently found among goats is especially well known as it can be transmitted to human beings causing Malta fever. It is caused by bacteria called *Brucella melitensis*.

- Symptoms: abortion takes place in goats as a result of Brucellosis. However, the goat is not always obviously sick. The infection does, however persist and the carrier does not get pregnant again. There is a danger that the Malta fever is transmitted to humans if they drink contaminated un-boiled milk or consume fresh goat cheese.

- Prevention: Vaccination. Always consider the possibility of Brucellosis if abortion occurs in a goat. If possible, let a milk sample be tested for the presence of the bacteria. For your own protection, boil the milk before use.
- Treatment: Kill infected animals.

Mastitis

Mastitis or udder infection is a disease found all over the world. Both acute and chronic forms exist. Bacteria are usually the cause. In particular poor hygienic conditions in the shed, unhygienic and improper milking provokes the disease. Production decreases strongly among affected animals and the milk is not suitable for human consumption.

- Symptoms: Sick animals have a swollen udder, sometimes it is only partially affected. The milk can become lumpy and stinking. The goat does not permit its young to drink and does not like to be milked.
- Prevention: Hygiene during milking and proper milking technique. Use a strip cup for early detection, look for flakes in the milk.
- Treatment: milk the infected udder empty as often as possible and massage it, at least 4 times per day. Inject antibiotics into the udder via the teat opening and canal after milking it empty.

Pneumonia

Pneumonia is a disease of the lungs which occurs frequently in young goats. Cold and wet weather and cold draughts increase the risks of this disease. It can be caused by virus, bacteria, lung worms or fungus.

- Symptoms: Loss of appetite, cough, dullness in appearance, nasal discharge, breathing difficulties and fever. The kids may die.
- Prevention: Good housing (ventilation), proper management and good feeding. Provide a good goat shed which should not contain too many animals. Deworm the goats when necessary and feed them well.
- Treatment: Keep the sick animal warm and separate, giving it good feed. Treatment with antibiotics may help.

4.4 Diseases due to feeding errors

A sudden change from one kind of feed to another can easily cause digestive problems in goats. Two frequently occurring problems are bloat (tympanites) and diarrhoea.

Bloat

Bloat can be caused by a physical obstruction in the throat but more often an excessive intake of feed which quickly starts to ferment in the rumen causing a sudden accumulation of frothy gasses in the rumen of the goat. Especially fresh wet green fodder which has been heating up for some time on a heap can have this effect. Excessive consumption of fresh humid legumes like alfalfa often causes this problem. Tuber crops which are no longer very fresh and sour grasses can have the same effect.

- Symptoms: Sudden and rapid swelling of the rear of the body, especially in the left flank. The animals do not want to eat anymore and do not chew their cud. They are frightened, jumpy, breath rapidly and become dazed when short of breath. They wobble and finally collapse, after which they often quickly die due to suffocation or heart dislocation.
- Prevention: Goats should slowly get used to a new kind of feed. Before grazing green and wet pastures, feed the animals some dry feeds (straws) or put them out for grazing later in the day.
- Treatment: Rapid handling is essential. If this is due to the accumulation of gasses in the rumen, position the animal so that the front of its body is raised and get rid of the gasses (make the animal burp) by pushing on and rubbing the left flank. You can also try to insert a firm hose into the rumen via the gullet so that the gas can escape. Make sure that the hose does not enter the windpipe! Let the animal drink at least 0.5 litres of vegetable oil as an alternative. In serious cases, make an opening in the left flank through the skin and the wall of the rumen. Use a trocard (thick, hollow needle) or scissors which you turn a bit. Leave the trocar or scissors in the flank until the gas has escaped. Disinfect the wound.

Diarrhoea

Liquid faeces can be caused by a sudden switch from one kind of feed to another, from dry roughage to fresh, wet, young grass for example. Worms, liver fluke or a disease called Coccidiosis can also cause diarrhoea. Young and weak animals are most sensitive.

- Symptoms: Liquid faeces. The animals are listless and eat little or not at all. They drink a lot and can be feverish. Due to dehydration they may die within several days. In case of worm infections and Coccidiosis it is possible to detect blood in the faeces. Anaemic symptoms (look at the mucus membranes) also indicate worms or Coccidiosis. A laboratory can confirm the diagnosis by checking the excrements.
- Prevention: Good hygiene and preventing overpopulation are the best ways to avoid the disease. Provide forage in a rack or net. If possible, allow the animals to graze in the same place only 2-3 days in a row so that they do not become infected by eggs of internal parasites.
- Treatment: Let the animals fast for a day, keep them warm and dry. Give them unrestricted access to clean fresh drinking water, preferably boiled when used for kids. If the animals are too weak to drink, you must force them to do so! One tablespoon of salt and a handful of sugar per litre of water have a positive effect. Mash up some active carbon and give a teaspoon twice a day. For worms, see the next section on parasites. In case of Coccidiosis treat all animals with sulphonamides, treat also animals that are not (yet) sick. Coccidiosis is very contagious.

4.5 Internal parasites: Worms

Infection with worms is a common occurrence. Worms can be found in the lungs, stomach, intestines and liver. Contamination with a few worms is unavoidable, should not cause worry and can even be useful in building up resistance against those parasites. However, too many worms weaken a goat. The goat gets more susceptible to diseases and may even die. Production and growth may decline even while no specific symptoms of disease show. Only if the infection is severe the animals will show it. Well-fed and cared for animals suffer less from parasites.

Ways to avoid infection by worms

- Try to avoid continual grazing by large herds. Otherwise a high level of contamination of grazing areas by worms will occur due to many larvae in the faeces.
- Management practices, such as rotational grazing and regular treatment of the animals against worms can prevent damage.
- As many parasitic worms are host specific, alternating the grazing of horses and/or cattle with goats and/or sheep can lower the extent of contamination of a pasture. Cattle eat the larva of the species which have the goat as host but which cannot harm the cattle and vice versa.
- De-worm both nanny and kids at weaning and keep the weaned kids separate from the rest of herd, if possible on a clean pasture.
- The presence of worm larvae in the field builds up during the rainy season. This is the most important time to protect your animals against worms or to de-worm.

Please note: when treating animals with de-worming medicines, the prescribed dose and method of administering it must be strictly followed. Overdosing is harmful for the animal. Especially young, weak and pregnant animals are sensitive. There is often local knowledge about medicinal plants which can be applied to help get rid of worms.

Liver fluke (Fascioliasis)

The liver fluke causes much damage. It can grow to at least 3 cm long and 1.3 cm wide. The liver fluke lives in and damages the liver. By sucking blood, anaemia is caused.

- Symptoms: The acute form, which occurs rarely, is an infection by very many flukes. The liver and stomach get badly damaged. Moisture enters the chest and stomach cavity as seen by the increased girth. The goat becomes sluggish, has difficulty breathing and can die within a few days. The chronic form leads to anaemia, sluggishness and thinning. Only rarely does death occur, in which case dozens of liver flukes are found in the liver.

- Prevention: Treat the entire herd. Prevent infection by avoiding swampy places when grazing. Ensure good drainage around the water troughs. Do not use any snail-killing chemicals as they are also very poisonous for other animals! Preventive regular dosing may be justified in some areas.
- Treatment: apply worm cures which are also effective against young liver flukes. If re-infection might occur, in the wet season or in boggy pasture, repeat the cure every 6 weeks.

Life cycle

Mature worms inside the liver of the goat lay eggs which leave the body with the faeces. The eggs grow into larvae which develop further and multiply in a certain kind of snail. This snail is found in moist swampy grazing places. After leaving the snail, the larvae attach themselves to plants and are eaten by the goat. The development of egg to fluke takes at least 5 months.

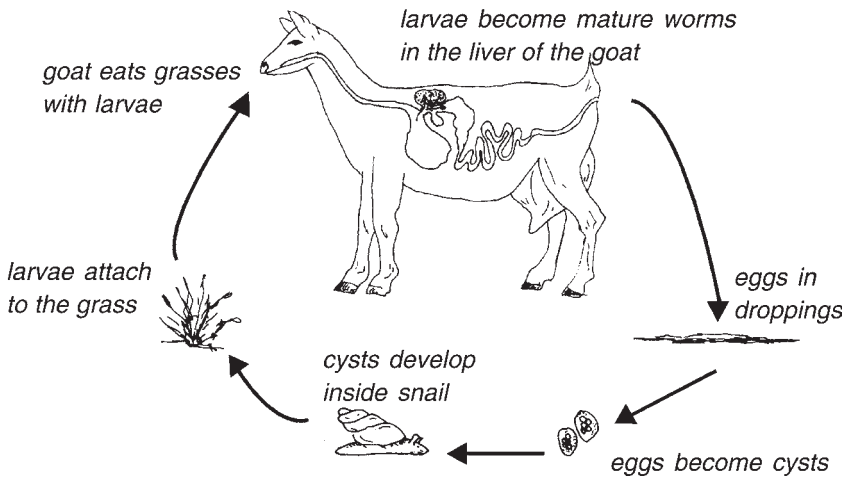


Figure 13: Life cycle of liver fluke

Roundworms and tapeworms

These worms attach themselves to the stomach or intestinal wall and live off the tissue or blood. The larvae also migrate through these tissues, therefore these worms can cause severe damage to the goat's health. They cause anaemia, infections and poor functioning of the digestion. Tapeworms which are found in goats cannot be transmitted to humans, which is possible for those tapeworms found in pigs and cattle. By properly cooking or frying the meat, infection is prevented.

- Symptoms: decreased appetite, less lively, a coarse dry coat, anaemia and diarrhoea or constipation because of too many worms.
- Prevention: De-worming and rotation of grazing areas. Avoid contact with dogs.
- Treatment: using worm medication for the entire herd.

Lungworms

These are roundworms which are found at the mature stage in the lungs. They cause irritation of the bronchial tubes and possibly lung infection if present in large numbers. The eggs are coughed up, swallowed and get onto the land via the manure. Within one week there are already contagious larvae which are ingested with the feed. Via the intestines and blood they get to the lungs, where they mature further.

- Symptoms: coughing, losing weight and possibly lung infection.
- Prevention and Treatment: see roundworms.

4.6 External parasites

Certain kinds of flies, mosquitoes, fleas, lice, mites and ticks can, at some point of their life cycle, parasitize on goats. They cause irritation of the skin which may lead to wounds. Furthermore, some of them can transfer disease or internal parasites. A general characteristic of these kinds of organisms is that they multiply phenomenally fast. General hygiene in the shed is the most important measure to avoid problems. Keep the immediate surroundings of the shed free of manure and other organic waste. There are also numerous kinds of acaricides (for the mites and ticks) and insecticide (for the others) available to keep the parasites under control.

5 Reproduction

Dairy goats have to give birth before starting lactation. Goats for meat have also to give birth to get kid(s) for fattening. Pregnancy only occurs after effective mating during heat, the gestation period is 5 months. It is possible for goats to produce 3 kids in 2 years, which is often convenient for meat production. With dairy goats the farmer has a choice: to kid his goats once a year or 3 times in 2 years with 3 much shorter lactations, or even one every two years.

In more temperate climates goats generally only come into heat during the period of shortening days, late summer and autumn. In many parts of the tropics goats come into heat throughout the year, provided there is adequate nutrition. In seasonal wet and dry regions it is advisable to have kid(s) born a few weeks before the rainy season starts.

5.1 Heat detection

When a doe is in heat she is ready for breeding and with effective mating she is able to become pregnant. The interval between heats is 17 – 22 days, with 21 as the most common. The heat itself may take anything between 6 and 30 hours.

Heat signs are:

- The goat becomes restless, bleating and tries to attract attention of other animals, specially the billy goat.
- She tries to mount other animals, she sniffs them and invites being mounted and sniffed at.
- She wags her tail, even when you put your hand on her loins.
- Once she accepts being mounted and stands, she is on standing heat (this is the most reliable indication of heat and the appropriate moment for mating).
- There is provocative urination in the presence of a billy-goat.
- The hairs on her back, pelvic region and tail head may be ruffed.
- The lips of the vulva are coloured (more reddish) and somewhat swollen.
- There may be discharge of clear (dried) thin mucus from the vulva, which can be attached to her tail and/or hindquarters.
- Often the milk production is reduced and the goat behaves differently.
- After heat there may be a bit of bloody mucus discharge on the hind-quarters and tail.
- Record the service and watch careful 3 and 6 weeks later.
- Check carefully as of 6 weeks after delivery if she comes back into heat.

Goats may be encouraged to come into heat by bringing them close to the buck (or billy). The shortening of days (as in temperate climates) also encourages the coming into heat. Flushing will increase conception rates and litter size. Flushing implies the increase of the plane of nutrition a few weeks before the desired breeding period, e.g. by providing some extra concentrates.

The doe in heat will try to approach the billy goat or buck. By placing the billy in a pen next to the goats, does in heat will attract attention. Otherwise you can walk the billy along the pens and goats in heat will present themselves. In larger farms a search billy can be used to detect the goat(s) in heat, but make sure he does not outsmart you by unwanted breeding of a goat in heat. To avoid unwanted or undesired mating, people tie a piece of cloth or

a back around the belly of the buck in front of his prepuce (sheath). In this way he can jump on any female in heat but not serve them effectively. This makes heat detection easy and it is effective to assure that the right buck mates with the right female.

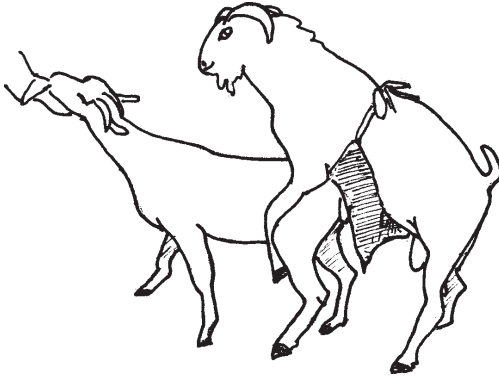


Figure 14: Billy goat with a cloth that prevents effective mating

Billy goats

Well reared billy goats reach sexual maturity at an early age, from about 5 month onwards, but should not be used too early or too frequent. They have a high libido, but their sperm production is not yet at full capacity. Mature billies can handle up to 20 females in a reasonable breeding period and young ones half of this at maximum. A well-developed mature male can serve several times a day, but not every day, so do not over use the buck as this reduces pregnancy rates. Select a good buck or billy for breeding with a good body conformation, adequate development and a good representative of his breed. Make sure that both his testicles are in his scrotum (sack, pouch).

Hornless goats

In some European breeds, like the Saanen, the breeding of a hornless male and female may result into intersexes or free-martin offspring. Such animals are neither male nor female and therefore useless for reproduction. So make sure you use at least one genetically horned animal when breeding. They may be dehorned.

5.2 Breeding

Once a doe has been identified as in heat, and her age and body condition are adequate she can be served by the buck. Artificial insemination is not common in goats. Plan ahead taking into consideration that the pregnancy will take 5 month (147 - 151 days) in relation to feed supply at kidding, marketing the kids for slaughter and your other workload (planting, weeding, harvesting etc.).

The litter size varies by breed and management, but some animals produce 1 kid, while others have 2 or even 3 kids per kidding. Young animals generally have smaller litters, while older animals may have a bigger litter. Selection for litter size is not very effective, but good nutrition and management can increase litter size.

The best is to take the goat to the buck and get her served in the second half of the heat period. So a goat identified in heat in the morning should be served in the afternoon/evening and seen in the evening/night served next morning. If she is still in heat some 12 hours after the first service she may be served again, this will enhance pregnancy rates. Taking the doe to the buck avoids severe “pick order fighting” after service. Make sure you record the service and the name of the buck, to avoid future inbreeding.

Please note: the leading goat (the most dominant one) will not accept the billy within the pen or flock, so get her out of the pen, e.g. into the corridor for service.

The success of breeding also depends on the selection of the most suitable animals. The buck should preferably be one of a twin born (more fertile) and represent the right breed characteristics. He also should have a high producing and prolific dam. Have a look at his offspring performance. The doe should have good body conformation, preferably twin born from a high producing dam and also have good breed characteristics. Recording the performance of the parent stock is important for the selection of (young) breeding animals.

There are several types of breeding systems: pure breeding, crossbreeding and upgrading are the most common and practical ones. Line-breeding and inbreeding are mating closely related animals. Both are not advisable for production purposes and may result in unwanted characteristics in the offspring.

Pure breeding

Pure breeding is breeding two animals of the same breed so the offspring will be purebreds too. However, this is not a guarantee for good performance, but must be combined with selection of male and female breeding animals. Selection may also be helpful in correcting weak(er) points, particularly in female animals. Pure breeding may be advisable where there is a good market for purebred breeding goats or the breed is the best under prevailing conditions.

Cross-breeding

Cross-breeding is breeding animals of different breeds, e.g. breeding a local with an exotic animal. Crossbreds generally do have (some) hybrid vigour (a stronger animal) and they may be more productive and healthy in the first generation. If you cross a dairy and meat breed, the female offspring will (most likely) produce more milk than the meat breed and produce heavier kids than the pure dairy breed.

In many cases criss-cross breeding is practiced. This is the continuous cross-breeding between 2 or 3 breeds. For example a farmer crosses his local dairy goat with an exotic buck, then the offspring will be bred with a local buck and these offspring bred again with an exotic male. In such cases reasonable hybrid vigour is maintained and a strong and productive herd can be maintained on the farm. Moreover animals may be better adapted to local conditions.

Upgrading

Upgrading is a replacement breeding program in which the original breed is (slowly) replaced by an exotic breed. Therefore a continued use of one

exotic parent, often the buck, is used. The first for crosses are 50 % local and 50% improved breed. In the 2nd generation there will be 75 % of exotic blood and in the next 87,5 %, in the 4th generation it will be around 94 % and such animals are often called grade. The 5th generation of the same breed male parent is often called pure. In such way the original breed is replaced for an exotic breed in 5 or 6 generations.

5.3 Reproductive cycle

After a successful service the goat is expected to deliver 5 months or 150 days later. Dairy goats can be milked up to 2 months before the expected next delivery and with meat breeds the kids should be weaned at least 2 months before the next kidding. Make sure the animals are adequately fed during pregnancy, as the growth of the foetuses require an increasing amount of nutrients. Steaming-up (mostly giving extra concentrates) just before the expected delivery is highly unwanted as it may cause nutritional, kidding and health problems at the start of the lactation.

Kidding interval

The kidding interval is the period between two consecutive kiddings and this depends on the desired management system.

With dairy goats there is the choice between one kidding per year, this gives a lactation of a maximum 10 months. With 3 kiddings in two years, this gives 3 lactations of maximum 6 months each. So one goat gives a maximum of 20 months of lactation in two years, the other goat a maximal 18 months of lactation in a similar period. The shorter lactation often gives a bit higher production per day, but the total production will most likely be rather similar. The general feeling is that the shorter the kidding interval, the more milk is produced and in a more efficient way. Both require a high standard of management and nutrition.

With goats for meat production the choice is for maximal offspring, so 3 kiddings in two years is an obvious choice, if the feed resources permit. However, if the farmer wants to have heavy kids at weaning or fodder

production is limited due to season, the choice may well be a once a year kidding. The planning for breeding may also be related to the market, as in some regions the price of an animal for slaughter varies considerably throughout the year.

Dry period

Regardless of the system chosen, the pregnant doe needs a dry period of 2 months. It is often believed that a new pregnancy will affect the lactation. However, this will not be the case until the 3rd month of pregnancy or with a very heavy litter (3 or more kids). The goat requires the dry period for a rest and to prepare the udder for the next lactation. Moreover, there will be severe feed competition between maintenance, lactation and pregnancy in that period

Make sure the dry period will not be too long (more than 75 days), as this will have a negative carry-over effect on the next lactation. A goat producing even a small amount of milk is more efficient in her feed intake and digestion, so keep milking her until 2 months before expected delivery.

Take care of adequate nutrition during the dry period, but make sure the goat does not become fat, as this will likely increase birth difficulties and may cause digestive trouble after kidding. The doe should have an adequate body condition, neither too thin nor too fat (fit but not fat).

5.4 Young animals

Young goats should have an adequate development and obtain at least $\frac{3}{4}$ of the mature body weight at first breeding. For well reared young goats this may be reached at about 7 months of age so the animal will give birth at about one year. However, the body weight is the determining factor. If young goats do not have sufficient development at breeding, or when a buck accidentally serves a too young or small animal, they will be hampered for life and never reach full production potential, either in milk production or in frequency of delivery or number of kids.

Suckling

When the dam is suckling the kids for a longer period, than the return into oestrus/heat may be postponed. The hormones that maintain the lactation and stimulate the milk let-down for suckling restrict the hormones that stimulate the reproduction. So suckling kids should be weaned just before they are 3 months of age in order to facilitate the dam to have 3 litters in 2 years. With very good nutrition and management, kids as of the age of 10 weeks may be allowed to suckle for just half an hour daily until the dam shows heat and then resume full suckling after impregnation. Once the dam resumes her reproduction, she will continue to show heat until served and pregnant again.

5.5 Breeds of goats

There is an enormous variety of breeds of goats, large and small breeds, specialised in dairy and meat. It goes too far to describe them in detail, but we will highlight a few breeds here.

Saanen: Originates from Switzerland, but at present is widely spread all over the world. The goats are large in size and have a white coat. Females obtain weights up to 65 kg and males till 75 kg. With good management goats will produce on average 3 l/milk per day. This breed is known for its intersex /free martin offspring, therefore horned animals are preferred, but they may be dehorned.

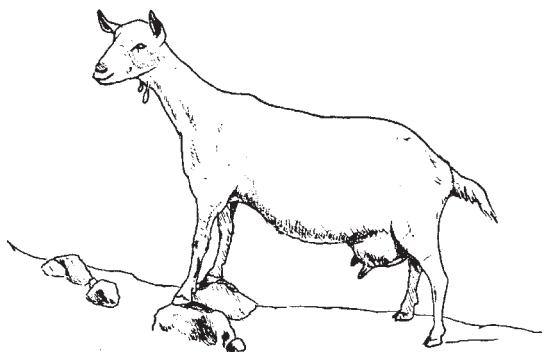


Figure 15: Saanen

Toggenburg: Also originated from Switzerland, and also are widely spread in the world. The coat is brown or chocolate. Females weigh some 50 kg and males 65 kg. With adequate care and nutrition they may produce some 2 to 2.5 l/of milk per day.

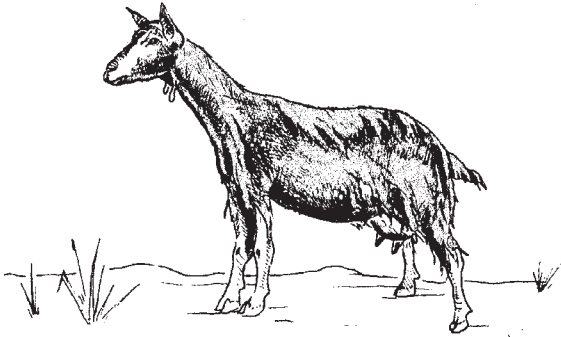


Figure 16: Toggenburg

Anglo-Nubian: The result of cross-breeding of Nubian and local breeds in England. The colours vary, but brown and white dominate. Females weigh 60 kg and males 70 kg. The animals are very adaptable to the tropics with a somewhat lower production than the Swiss breeds.

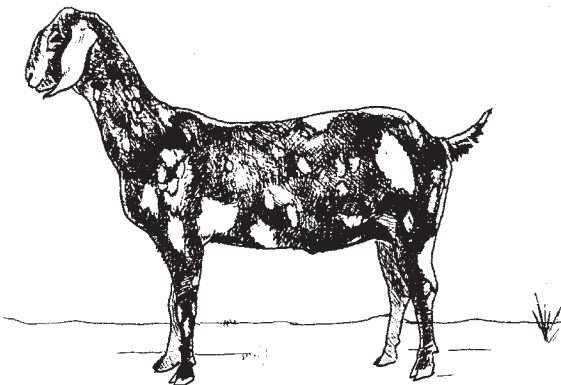


Figure 17: Anglo-Nubian

Alpine: This breed originates from the Alp region in Europe. The animals have a good size and an enormous variety of colour of their coat, from black to white. Their weight is 60 kg and 65 kg respectively for females and males. The breed has good potential for both milk and meat production.

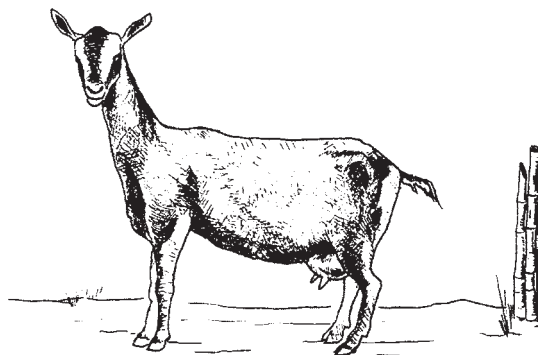


Figure 18: Alpine

Jamnapari: A large breed originated from India with large lopped ears, and a large variety of colours, but often black or brown. The adult weight is some 65 to 75 kg. This breed has a good adaptability to the tropics and potential for both milk and meat production.

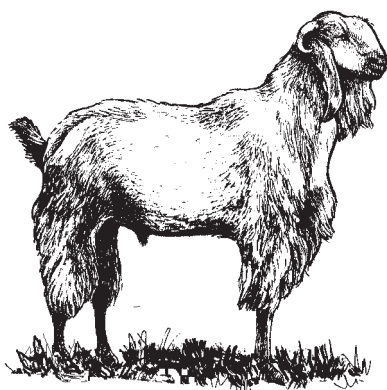


Figure 19: Jamnapari

Boer goat: This breed is the result of long selection of local goats in South Africa. The colour is almost always white (with a brown neck and a black or brown head). The animals have a good fertility and are well muscled. They can be very heavy with males weighing up to 130 kg and females 80 kg. They are mainly kept for meat production, but have also a reasonable potential for milk which is often used for suckling the fast growing kids.

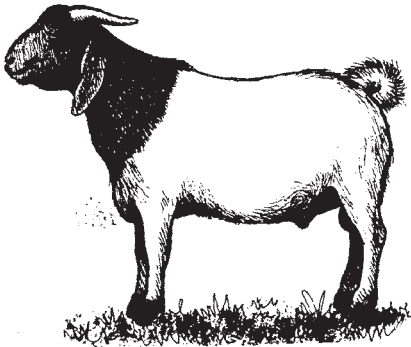


Figure 20: Boer goat

5.6 Desired characteristics of male goats

The buck or billy is half the herd, therefore it is very important to select the right male for reproduction.

The dairy buck

- excellent health and sexually virile
- a masculine body with medium-length head
- a strong, broad muzzle with large open nostrils
- bright eyes with pink mucosa
- no under bite or overbite
- a strong, straight, smooth back
- a long, wide and nearly level rump
- strong, sturdy legs that are wide apart and squarely set
- solid feet/hoves
- a pear shaped scrotum with 2 testicles of equal size
- a deep heart girth and wide chest floor

The meat buck

Beside the above mentioned points, attention should be given to the following:

- Meat bucks should exhibit masculinity and adequate muscling.
- The head should have a broad strong muzzle and horns set far apart.
- The animal should demonstrate adequate muscling, particularly in the chest, back and hindquarters.

6 Kid and young stock rearing

The new-born female kid should become a milk-producing goat in about 1 to 1.5 years' time. However, kids may die and mortality means a loss of money. Far worse is morbidity, the chronic disease status of kids resulting in stunted animals. Morbidity affects all aspects of the animal during its entire life: its growth, the age of first kidding, milk production and kidding interval.

Proper young stock rearing preventing mortality and morbidity is extremely important for the economic situation of the farm. This starts with the care of the does around kidding. The next step is to help the kid – a monogastric animal at birth – to become a ruminant. In the recently born kid only the true stomach, the abomasum is developed. The other three stomachs, especially the rumen, develop when the young animal starts eating good quality roughage. This process takes about 8 to 10 months.

6.1 Kidding

A pregnant goat will give birth to her kid(s) 5 months after the last successful mating. The unborn kid(s), particularly when the goat carries 2 or more kids, grows fast in the last two months of pregnancy. Moreover, the milk

producing tissues in the udder have to be renewed or developed. This is why the goat has to be dried off 2 months before the expected kidding date. The goat should be observed regularly a few days before the expected kidding. If possible she should be separated from the herd, in a clean, roofed place with dry bedding and without obstacles that might cause injury.

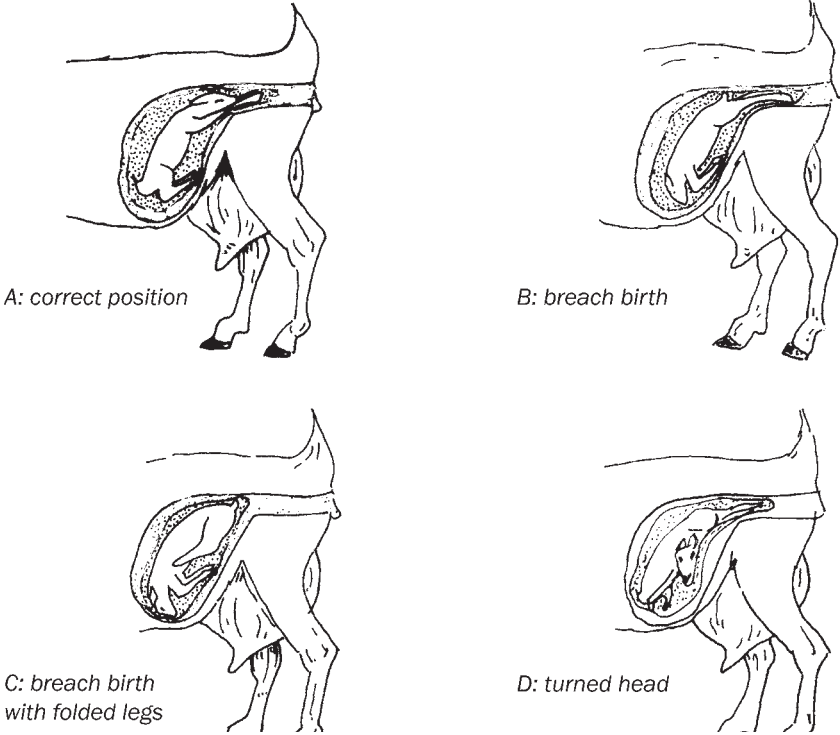


Figure 21: The unborn kid, normal position and some abnormalities

At the start of delivery the animal becomes restless, lies down and stands up again, and attempts to urinate, the udder and vulva are swollen. The uterus starts contracting but this is not yet visible. The appearance of the water bladder is the first real sign. In a normal delivery the kid's front legs and mouth appear first. Once the head is born the rest of the body will fol-

low; only the hipbones may cause some delay. If it takes too long, pull on the front legs, but only when the goat herself is pushing.

It is best to keep an eye on the goat, but let her do the job. In general the dam will lick the kid(s). You have to make sure that the nose and mouth are free of mucous. In case of twins the second kid is usually born within 10 to 15 minutes. If assistance at kidding is really unavoidable, make sure that your hands are washed and clean and wash the vulva of the goat before starting. In case of doubt or lack of experience, call the vet or an experienced person (with small hands).

The afterbirth or placenta should be expelled within 3 to 4 hours. If this does not happen within 12 hours, call for expert help. Do not pull or put a weight on the afterbirth, this may damage the goat's uterus and cause serious problems. Allow the kid(s) to suckle directly after birth as this stimulates the expulsion of the placenta and the suckling of colostrum.

6.2 Kid rearing

A new-born kid needs milk for about 3 to 4 months. However, with good quality concentrates the kids may be weaned earlier. After weaning, the kid(s) can do without milk, but they still need high quality feed to stimulate their growth and development.

The first days

Right after birth the umbilical cord should be disinfected with a solution of iodine. A new-born kid does not have any resistance against diseases or parasites, so it needs good care, proper housing and adequate nutrition to prevent it from becoming ill. Preferably new-born kids should be housed in an individual kid pen; twins can be kept together in one pen. Assure a dry floor with bedding or a slatted floor and no draught of cold air. After 3 weeks, kids can be housed in a group.

The new-born kid needs colostrum as soon and as much as possible, preferably within half an hour, but at least within 2 hours after birth. 'Colostrum'

is the milk the dam produces during the first 3 days after kidding. Colostrum contains antibodies and it gives the kid the so-called 'maternal immunity', which is specific for the farm. Some farmers allow the kid(s) to stay with their dam for 2 or 3 days to get the maximum amount of colostrum. The problem is that it may be difficult to teach the kid to drink from a bucket thereafter; in such cases a bottle with a teat may be an option. In the case of twin or triplets make sure that all the kids get enough colostrum. This can be done by keeping them separate and hand feeding freshly milked colostrum. Some farmers milk the goat 3 to 5 times a day and feed the colostrum immediately to the kid(s), about 50 ml each time to a total of 0.2.l colostrum a day, increasing to 0.6 – 0.8l milk a day. This is important for building up immunity as quickly as possible. Maternal immunity lasts for some 2 to 3 months and within this period the kid has to build up its own immunity. Best is to allow the kid some light exposure to pathogenic organisms and parasites. Caution: make sure it is only a light exposure!

Feeding till weaning

Milk is a complete and natural feed for the young kid. During the first 3 to 4 months of its life it needs about 10 % of its body weight in milk per day. Too little milk will hamper the development of the kid, too much may cause diarrhoea. Stick to the right amount and the kid will make a good start. To train the kid to drink from a bucket, let the kid suckle on a finger and lead it towards the milk in the bucket. After a few times it will drink all by itself. Some farmers prefer a bottle with a teat. Make sure the used equipment is cleaned properly (put it upside down in the sun) and strict hygiene is observed, otherwise the kid will get diarrhoea.

From the second week onwards a small portion of concentrates and some roughage should be offered. A special concentrate is preferable, but any good concentrate will do, provided that it does not contain urea or cottonseed cake. At the beginning, the concentrate can be given in the same bucket as the milk. Once the kid starts eating it readily, it should be given in a special feed trough.

Roughage, preferably hay of a good quality, will stimulate rumen development. It can be tied with a piece of rope to the side of the pen so the kid can start eating it suckle-wise. Once the kid begins to really eat the roughage it may be given in a rack and ad libitum. Fresh roughage should be supplied, preferably twice a day. Make sure the kids have clean water available at all times and, at a later stage, some minerals.

Although very detailed feeding schedules exist, an effective and simple system is to give the kid some 0.2 l of milk four times a day from the second week onwards, gradually reducing it to two times a day with an increased amount of concentrates, up to 0.2 kg a day. If the kids consume an adequate amount of concentrates, then a minimum of 25 l of milk will suffice in the first six weeks. If concentrates are not available, more milk per day must be given for a longer period. At weaning, kids of improved breeds (50 kg mature weight or more) should weigh at least 7 kg and consume 0.2 g of concentrates per day. After weaning, the kid still needs good quality roughage and concentrates to continue its development. Often concentrates are considered too expensive for kids, but remember that the nutritive value of 1 kg good quality concentrates is equal to that of 3 to 4 kg milk. The period after weaning is often the most difficult, especially if high quality feed is not available or is considered too expensive. Kid mortality is highest during the first 3 to 4 months.

Billy kids

On most dairy goat farms billy kids are neither used nor needed. Rearing them costs money, so unless needed to stimulate their dams' milk let-down, sell or slaughter them as soon as possible. Otherwise, if they are crosses with meat type, they can be reared and fattened, when economically feasible. If young billy kids are kept for meat production, it is worthwhile to consider castrating them. This can best be done with an elastrator when (very) young. Ask the local veterinary or -assistant if in any doubt.

Suckling

Many local and crossbred goats will not let-down their milk without their kid being present. This does not necessarily mean that the kid has to suckle first; often its close presence will do. If this is the case the goat will stop producing if her kid dies. Therefore try milking the goat without the kid. Some farmers allow the kid to suckle the last milk for 5 to 8 minutes. This may help to reduce mastitis, but as the last milk contains the most fat, the kid may get too much fat. It is better to leave (part of) one teat for the kid, but not always the same teat.

In some areas goats are milked in the morning for home consumption or sale and thereafter the kid(s) join its dam and are allowed to suckle till mid-day or early evening. From then on until the next morning milking, kid(s) and dam remain separated.

Remember

Points to bear in mind when kid rearing:

- Immediate provision of colostrum to the new-born kid is essential.
- Feed an adequate amount of milk from a clean bucket or bottle, right after milking the dam.
- Introduce special or good quality concentrates at about one week of age where possible.
- Start giving roughage during the second week, preferably good quality hay.
- Make sure the kid pen is dry, draught free with a slatted floor or adequate, tick free, bedding.
- Provide the kid with fresh and clean water from early age onwards.

6.3 Young stock rearing

The age of weaning is a point of discussion. With dairy goats one wants to have as much milk as possible for home consumption or sale, but the kid(s) also need milk. For meat goats milk is not a problem, the kid(s) can suckle all they need, there is no competition. When good quality concentrates and roughage are available dairy kid(s) can be weaned at about 6 weeks, or be

fed artificial milk based on powder. Depending on the production orientation the farmer has to make a choice, but it always costs money, either through less income or by buying good concentrates. If goat milk fetches a much higher price, kids can be reared with cow milk.

After weaning many kids are fed on roughage alone, but (often) this is not enough for adequate growth. Generally, roughage needs to be supplemented with kid (calf) or young stock concentrates till the age of 1 year at least, though this depends on the roughage quality and season. With good quality roughage, a growth of 20 to 50 grams per day is feasible. However, the required growth for a kid to conceive at about 7 months is 150 - 160 grams per day, necessitating that supplements of at least 0.25 kg of concentrates per day are provided.

Many farmers give the best quality roughage to their dairy goats and the young stock gets what is left. This hampers their development and they might remain stunted for the rest of their lives. Young animals need adequate nutrition and this investment will be repaid once the animal starts producing milk.

Once the young goat has kidded and started her productive life, rearing/growth is not yet complete. She will continue growing and developing during the first lactation. The extra feed required, the 'youth allowance', is about 20% energy and protein above the daily maintenance requirements. This youth allowance must be taken into account to enable the goat to develop her production potential. Goats reach full maturity at 2 to 2.5 years of age, depending on the breed.

7 Milk production and slaughtering

In general, milk is a very nutritious drink. This is especially true for goat's milk as is easier to digest for humans, especially for children than cow's milk. Milk is a healthy contribution to daily requirements, it supplies protein to the diet. Especially for children who are still growing it is important to eat sufficient protein. Clean milk may save lives, but dirty milk or milk from diseased goats may cause diseases or in serious cases may cause death. Products in which the milk has been processed and made into cheese, yoghurt or buttermilk, do not present any difficulties.

Practical reasons for proper and hygienic milking and milk handling in dairying are:

- to produce clean milk of good keeping quality;
- to prevent and control mastitis, a contagious disease that affects the production and the quality of milk;
- to deliver good quality milk to consumers and processors.

Milk is an ideal environment for microorganisms like bacteria to multiply, especially in warm conditions. Microorganisms may cause souring of the milk and hence be rejected by the consumer or the milk collector. Filtering the milk after milking removes visible dirt like hairs and larger pieces of

soil and dung, but not the very fine dirt particles or the invisible bacteria. Good standards of hygiene are of the utmost importance for the quality of the milk and its products, as well as for the producer since the milk price often depends on quality; poor quality milk will be rejected. The consumer wants a safe product and the processor needs good quality milk for processing.

The handling of milk strongly affects the quality of the finished product. On leaving the udder, milk from a healthy goat contains a negligible quantity of bacteria and no dirt. If good hygiene is practised the contamination outside the udder can be kept to a minimum.

Good quality milk:

- is produced by healthy goats;
- is not contaminated with water, dirt, antibiotics, detergents and bacteria during or after milking;
- does not smell or taste bad;
- has not deliberately been adulterated with water, sugar, salt or flour (addition of water, in particular, may cause contamination by microorganisms and pose a threat to human health!);
- is stored and transported in a proper way;
- is a healthy food.

7.1 Clean milk

Clean milk production depends on the milker, the goat, the milking utensils and equipment used, the shed including the milking place and the handling of milk.

The milker

The milker should be healthy, clean, have clean hands with short fingernails and wear clean clothes. He or she should milk the goat paying full attention to the task and not smoke, spit or cough while milking. The goat should be milked as quickly and completely as possible, and preferably always be milked by the same person. By calm and gentle handling, touching the

goat, talking to her and maintaining routine actions during milking, she will feel at ease. If the goat is fed concentrates, feed them during milking.

The goat

To prevent dirt from dropping into the bucket during milking it is advisable to shave the hairs of the udder twice a year, especially around the teats. Brush the hair on the flank of the goat on the side of the milker frequently. The goat should be without diseases. Milk from goats with mastitis is not suitable for human consumption.

Utensils and equipment

Buckets, milk cans and cloths for cleaning the udder and cloths used for straining the milk are frequently the source of bacterial contamination of the milk. The surface of the milk utensils like the buckets and cans should be smooth and without seams and have rounded edges to make them easy to clean. Stainless steel is the best material but it is expensive. Good plastic buckets can be used if well taken care of. Aluminium milk cans are often used for transport. Special care should be given to cleanliness of the cans, including the lid.

Udder cloths and straining cloth need careful cleaning too. Paper towels for udder cleaning and disposable cotton pads for straining the milk are advisable, but may be expensive or not available. A strip cup for routine mastitis testing can be made from an empty tin and a piece of black inner tube.

It is essential to use clean water for utensil cleaning. The procedure is as follows:

- Immediately after milking, rinse all the utensils with cool water to remove milk residues. It is rather difficult to clean utensils after the milk has dried and sticks to them. Use cool water, as hot water for rinsing will make the butterfat stick to the utensils. Rinse the milk can with cool and clean water immediately after milk delivery.
- Brush all utensils thoroughly with hot water and detergent or soap. Keep separate brushes for the inside and outside of the utensils.

- Rinse all utensils with clean, cool water to remove dissolved dirt and detergent.
- A second rinsing with a disinfectant may be considered.
- If no disinfectant is used or available, the milk cans and buckets should be left drying upside down on a rack in the sun. The sun kills bacteria and acts as a disinfectant. Rinse again with cool water before use to remove dust. If a disinfectant is used the utensils can be stored inside, upside down. Never dry utensils with a towel or cloth.
- Rinse the cloths after milking and hang them outside, if possible in the sun to dry. Once a week the clothes should be washed or boiled with hot water and soap, rinsed and left to hang drying outdoors, exposed to the sun.

The shed

Cleanliness is important within the goat house, also important for fly control. Special attention should be given to the resting place (slatted floor/clean and dry bedding materials), but watch out for tick infestation in the bedding materials. Maintain high standards of hygiene in and around the shed with proper drainage and facility for storage of manure.

7.2 Milking

Milk let-down

Milking deserves full attention, because it affects the yield, lactation period, butterfat percentage of the milk and the health of the udder. Milking should take place in a quiet place without shouting and yelling so that the goats feel at ease. This is achieved through a routine process with the usual milker who talks and acts quietly. Feeding of fresh roughage or concentrates and rattling of utensils will trigger milk let down. A good cleaning and massage of the udder is necessary for the goat to feel at ease and stimulate milk let-down. The swelling of the teats is the sign to start milking. Sometimes the presence or even the suckling of a kid is necessary to stimulate milk let-down. Milking should not start before let-down has occurred. The let-down lasts for about 5 to 10 minutes and milking should

be completed within that period. If the goat experiences pain or is stressed, this process will be disturbed and milk let-down will not occur.

Preparation

Inspect each part of the udder for mastitis before milking starts, by squirting the first 2 draws of milk of each teat in a strip cup. Some watery first milk is normal, the trained eye can recognise abnormal milk, which may show discoloration, flakes, clots or wateriness. The colostrum may contain some blood or blood clots.

It is best to sit on a stool, preferably on the right side of the goat. This will give the milker a stable position and prevents the goat from kicking the bucket, or dirt falling into it. For ease of milking a raised platform will be convenient. With a feeding rack they can be easily constrained. The platform enables the milker to milk the goat more comfortably (prevents “hanging” on the teats).

Proper milking

Full hand milking is recommended. Stripping is slower than the ‘full-hand’ method and may cause damage to the teat and udder tissue and hence increase the risk of mastitis.

In ‘full-hand’ milking you close your thumb and index finger around the teat and extract the milk by squeezing progressively with each finger in turn, starting with the index finger and using minimum pulling on the teat. In this way the milk is squeezed out of the teat.



Figure 22: Hand milking, correct milking



Figure 23: Milking by stripping, a less desired way which can be painful for the goat

If the udder is not milked out completely, the drying-off process will be accelerated. This means that the milk production of the goat will gradually drop and the length of the lactation will shorten. The goat is thus ‘milked dry’ as she adjusts her production to the amount of milk removed during milking. It is better to use the dry method when milking. This means that during milking the milker should not dip the fingers in the milk in order to wet the teats. This is unhygienic. Although udder cream is frequently used to make the teats supple, it is better to apply it after milking.

Milking time

High yielding goats are milked twice a day and the interval should be as regular as possible, for instance, 6 am and 5 pm. If milk can be sold, sell it as soon as possible after milking and if it is for home consumption, boil it and let it cool down.

7.3 Milking procedure

1. Before milking, rinse the utensils and drain them properly. The noises will already stimulate the goat.
2. Offer some tasty concentrates or roughage just before milking. Dry meal concentrates can be mixed with some water to make it easier to eat and prevent dust.
3. If really necessary, tie the hind legs of the goat, but prevent wounds.

4. Wash hands.
5. Clean the udder and the teats, preferably by rubbing gently with a dry coarse cloth. Only use water if the udder and teats are very dirty and take care to dry well with a cloth. If available, some udder disinfectant may be added to the water for cleaning. Follow the instructions for dilution carefully.
6. Check the first squirts of milk of each teat in the strip cup for mastitis.
7. Milk quickly paying full attention.
8. Massage udder and extract the last milk.
9. After milking, if possible, dip teats in a teat dip solution to prevent mastitis.
10. Record the milk yield and pour milk into the can.
11. Offer some roughage to the goat immediately after milking to keep her standing for about one hour. The opening of the teat will then dry and close and largely prevent the entry of mastitis-causing bacteria and dirt.
12. After milking all the goats, rinse and clean the utensils.
13. Clean the dairy shed and milking place.
14. Deliver the milk as quickly as possible or boil and cool it.

7.4 Slaughtering

Besides milk, meat is the most important goat product. The slaughtering of goats yields meat, but also other products like blood, bones and hides. A goat can be killed by slitting its throat. By pulling the head slightly back, the throat is stretched which makes it easier and quicker to slit. Catch the blood in a bowl for later use. When the animal has finished bleeding, it can be skinned.

Skinning: Depending on local custom, first the head is removed. Subsequently the animal is placed on its back and is slit open from the neck to the udder or scrotum. The legs are then cut off. After that, pull as much of the hide on the stomach free by hand. This prevents damage to the hide and the carcass. Then slit the hide open from the udder or scrotum to the anus. After the skin around the tail has been freed, the rest of the hide can be pulled off.

Now cut the wall of the stomach open from the breast down to the hind legs. The guts must be tied up to prevent the carcass from being polluted by the contents of the rumen. The large intestine is also tied up 15 to 20 cm from the end. The breast can be sawed or hacked open.

The animal is then hung up by its front legs. First remove the bladder and uterus or penis, after that remove the intestines and stomach. Carefully pull or cut them loose. Remove the lungs, heart and liver. Take special care not to damage the gallbladder (green bladder on the liver) because it will spoil the meat with a bitter taste.

8 Records

Farmers may remember important events and data, but often the exact information is easily forgotten. However, information about animals, inputs and prices are very useful management tools. Recording and administration on the farm are important, but should be kept simple and effective. It should provide information on the farm's economic situation, production aspects and cash flow. Technical information, like amount of concentrates fed, gives important management information when combined with prices and costs. Records about fertility, kidding interval and disease are the basis for management decisions. Technical and economic records can be combined and provide both the farmer and the extension officer with the required information about the actual situation on the farm and possible developments.

8.1 Diary

In the daily routine of work it is convenient to use a diary to make note of all the events in order to transfer the information to the proper records at a more appropriate time. Recorded data should include: purchase of inputs and sales, price per unit and total value. Examples are: feeds, fertilizers, equipment, animals, hired labour, veterinary (and reproductive) services.

Dates of events should also be recorded. Most important are milk yield, heats, services, births, diseases and treatments of animals as well as harvests and yields of crops. Be as precise as possible with such basic data.

8.2 Animal records

On a dairy goat farm the animals are the most important so relevant information about them should be collected. This information will help you with taking action like servicing and drying off and making decisions about whether to keep the animal or dispose of it.

The best thing is to keep individual records of each animal. A card is usually used to record: births, services, and production data, drying off dates, kidding intervals, vaccinations and treatments. Table 3 shows the front-side of such a card, Table 4 the reverse-side, containing data about health.

Table 3: Individual goat card

Goat name: Clarita		Date of birth: 15/6/11		Breed: crossbreed	
Name of father: Danny			Name of mother: Clara		
Kids:					
Litter No.	Service date and name	Date kidding	Litter size M + F	Weaned M + F	Remarks
1	19/2/12 John	20/7/12	1F	1F	
2	30/10/12 John	28/3/13	2M	1M	1 died of Diarrhoea

Table 4: Example of an individual goat record: HEALTH

HEALTH card		Name of goat: Clarita	
Date	Vaccination	Date	Treatment
15/12/11	Brucellosis	12/2/13	Hoof care
Remarks			

The frequency of recording the daily milk yield of the individual goats can vary. On most small farms measuring the daily milk yield twice a month will be sufficient. Sometimes a calibrated cup will do the job.

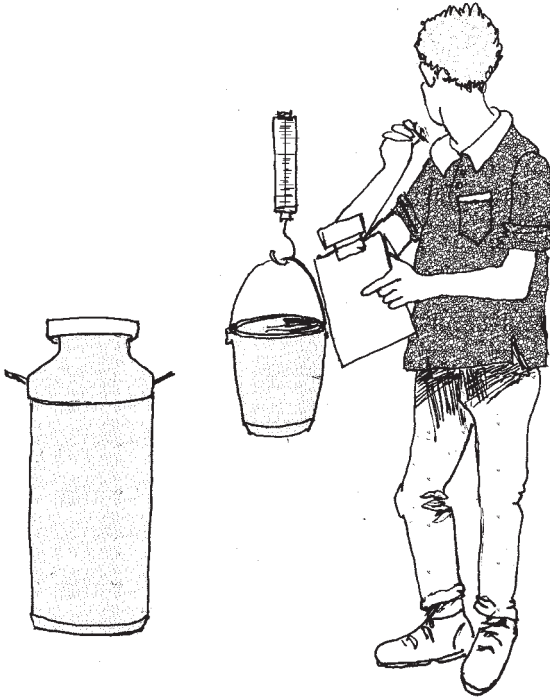


Figure 24: Recording the milk yield of individual goats

Table 5: Milk production records, measured twice a month

Goat's name	Date kidding	MILK YIELD in kg						Monthly total*
		Month: June			Year: 2013			
		First week of the month			Third week of the month			
	AM	PM	Daily total 1	AM	PM	Daily total 2		
Clarita	30/4/13	1.1	0.9	2.0	1.0	0.9	1.9	58.5
Bonny	28/2/13	0.8	0.5	1.3	0.7	0.6	1.3	39.0

* Monthly total = 15 x (daily total 1 + daily total 2) in kg

Herd size

The herd on a farm is always bigger than the number of productive goats; it includes young stock, kids and there may also be a billy. The cost of rearing and maintaining these animals is also borne by the productive animals. The cost of rearing young stock is regarded as an investment, with the hope that these animals will be efficient producers in the future, replacing old and less productive goats. Part of this investment may be recovered by the sale of culled goats. Therefore, all the cost and effort related to young stock, including labour, feed, housing and health care, are part of the farm and should be included in the records and analysis.

Table 6: Example of an individual billy-goat cart

Goat name: John		Date of birth: 15/8/11		Breed: ¾ cross	
Name of father: Bill			Name of mother: Sara		
Kids:					
Litter No.	Serviced	Date kidding	Litter size M + F	Weaned M + F	Remarks
1	Bonny	28/2/13	1F	1F	
2	Clarita	28/3/13	2M	1M	1 died of Diarrhoea
Diseases:					
Remarks:					

8.3 Financial records

All activities on a farm are geared to raising an income for the farmer and his family. It is crucial to keep track of the money coming in and going out, so a simple system of income and expenditure will give much insight into the situation and will enable the farmer to make the right decisions.

The information from the diary can best be transferred to the records weekly and analysed at the end of each month. This will often give enough details and missing pieces of the jigsaw may still be remembered. The monthly overview provides good information for a situation analysis. Moreover, this can be used later for the yearly records and analysis.

Table 7: Financial records

EXPENSES			RECEIPTS		
Date	Description	Cost	Date	Description	Value
1/6/13	10 kg concentrates	19.0	31/5/13	50 kg milk	105.0
15/6/13	Parasites treatment	8.5	27/6/13	Male kid sold	25.0

To be able to calculate the cost price of the milk, all the direct cost have to be taken into account. These include; concentrates, fertilizers used for fodder, chemicals, drugs, minerals and hired labour. The cost of kid rearing is often offset against the income from culled goats. The cost of long-term investments, like building and fodder improvement can be estimated. This total cost can be divided by the total amount of milk produced thus arriving at the cost price per kg of the milk. The difference between the cost price and the received price is the reward for farmer.

8.4 Use of records

Record keeping only makes sense if the information is used to evaluate the performance of the dairy goat farm and as a basis for decision-making. The

local extension officer can help with the analysis of the records and the economics of it. An annual cost-benefit analysis can be obtained by subtracting the total cost from the total income of the dairy. All of this can help plans for further developments of the dairy farm.

Appendix 1: Protein and energy requirements and feed values

The protein and energy requirements are expressed differently in different countries. In this booklet, the energy requirements are expressed by Metabolisable Energy (ME) in MegaJoules (MJ) (1 MegaJoule = 240 Kilo calories). In many countries the 'Total Digestible Nutrients' (TDN) is used as a measure for energy. In French countries energy requirements are expressed as 'forage units' for Lactation or for Meat production, resp. UFL and UFM.

1UFL = 7.2 MJ ME/kg; 1 UFM= 7.7 MJ ME/kg; 1.0 kg TDN = 15 MJ ME

The protein requirement is expressed in terms of grams of Crude Protein (CP).

In the tables you find the nutritional needs of goats and the nutritional values of several feeds. Abbreviations used in the tables:

DM: dry matter in the feed, which is the remains after drying in an oven.

CP: Crude Protein

Table 8: Daily energy and protein requirements and feed intake of goats of different ages and weights for maintenance including early pregnancy), plus low activity (intensive housed management) and high activity (grazing sparse vegetation)

Weight kg	Energy ME (MJ) per day		CP g/day		DM intake			
	Low act	High act	Low	High	Kg/day		As % of Weight	
					Low	High	Low	High
10	3.0	4.2	27	38	0.36	0.5	3.6	5.0
20	5.0	7.0	46	64	0.6	0.8	3.0	4.2
30	6.8	9.6	62	87	0.8	1.1	2.7	3.8
40	8.5	11.8	77	108	1.0	1.4	2.5	3.5
50	10.0	14.0	91	128	1.2	1.7	2.4	3.3
60	11.4	16.0	105	146	1.4	1.9	2.3	3.2

Table 9: Additional daily requirements of Energy and protein for production

Type of Production	Energy MJ/day	CP g/day	DM intake kg/day
Per 50 g growth	1.5	14	0.2
Late Pregnancy	6.0	82	0.7
Per kg milk (4%)	5.2	72	0.4-0.5

Table 10: Dry matter content and feed value (fresh base, as fed) of several feeds.

Kind of feed	DM%	g CP/kg	MJ ME/kg	Quality
Roughages				
Young grass	20	25	1.9	good
Old grass	50	20	3.0	poor
Good hay	85	50	7.8	reasonable
Rice straw	90	35	6.0	poor
Leucaena browse	30	48	2.8	good
Alfalfa	25	24	2.0	good
Cereals				
Maize	87	90	11.7	good
Sorghum	88	100	11.8	good
Pulses				
Field beans	87	250	11.3	good
Cow pea	88	220	12.6	good
Groundnut, with shell	94	190	20	good
Groundnut, shelled	93	240	28.5	good
Soya bean	89	300	17.3	good
Oil seeds by-products				
Cottonseed cake husked	92	400	10.5	good
Sunflower cake husked	92	450	9.1	good
Groundnut cake shelled	91	400	12.9	good
Soybean meal	90	440	11.9	good
Coconut meal	90	210	10.3	good
By-products				
Rice bran	90	130	9.5	good
Wheat bran	87	80	10.8	good
Brewers' grain, dry	90	270	10.6	good
Molasses	75	0	8.0	good
Cassava peelings	87	20	11.4	good

Example of calculating a ratio

Suppose you have a goat of 20 kg which you want to grow 100 g a day. The feeds available are cowpea and old grass. How much of these must you give the goat?

If this goat is housed (low activity), it needs:

$5.0 + 2 \times 1.5 = 8.0$ MJ Energy and $46 + 2 \times 14 = 74$ g CP per day (see tables).

In table 3 you find the following values for the energy (ME) and protein (CP) content of old grass and cowpea per kilogram of feed:

old grass:	3.0 MJ ME	20 g CP
cowpea:	12.6 MJ ME	220 g CP

Ensuring that there is sufficient protein in the ration is the most difficult part. In this case the cowpea provides the protein. We give the goat daily: $74/220 = 0.3$ kg (300 g) cowpea.

This product satisfies most of the protein requirement. At the same time, this amount of cowpea daily provides energy: $0.3 \times 12.6 = 3.8$ MJ ME.

To provide the remaining energy, equal to 4.2 MJ, you use the grass. This means the goat must eat $4.2 / 3.0 = 1.4$ kg of grass daily. Total dry matter intake would be $0.3 \times 88/100 + 1.4 \times 50/100 = 1$ kg per day. That is the same as suggested in the tables: $0.6 + 2 \times 0.2$ for growth = 1 kg.

Total energy intake would be 3.8 MJ from cowpea plus 4.2 MJ from grass, protein intake 66 g from cowpea and 28 g from grass is 84 g in total. Both are correct.

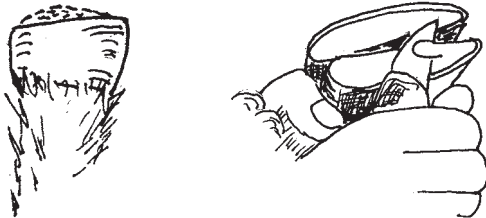
Appendix 2: Hoof Care

If goats walk a lot on soft ground or are kept housed for long periods, their hooves do not wear down enough. The hooves grow too long and crooked and the goats cannot walk comfortably. Infections can also occur. The extra growth must be removed in time and you have to do that about 4 to 6 times per year.

1. Take a knife and first remove all dirt between the hooves until you can see the sole.



2. Cut any crookedly grown hooves down to length. In doing so, cut the hoof (toe) down to the sole.
3. Hollow the cut out, if necessary, between the split between the hoof halves.
4. Bring the ball of the sole to the same height as the toe.



5. Make the sole even. Infections between the sole and hoof must be cut away. In doing so, you may remove some of the sole (callous) but not too much living tissue. Disinfect larger cuts. Normally the hoof will quickly get dirty again anyway. Minor bleeding rinses the dirt out by itself, therefore do not be too worried.



6. *Hoof after treatment: the ball of the sole at the same height as the toe and a clear split between the hoof halves.*

Further reading

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Useful addresses

British goat society, UK

www.allgoats.com

Publishes a monthly journal for members

Dairy goat journal, UK

www.dairygoatjournal.com

DIO, Foundation for veterinary Medicine for development cooperation, the Netherlands. www.dio.nl

Gives support and advice in the field of animal health and production.

FAO, Food and Agricultural Organization of the United Nations, Italy

www.fao.org

Heifer International, The Netherlands.

Heifer is an NGO, specifically oriented to start and support livestock projects for poor and emerging farmers (female).

www.heifer.org

ILRI, International Livestock Research Institute, Ethiopia

www.ilri.cgiar.org

International Goat Association, USA

www.iga-goatworld.com

Publishes The Small Ruminant Research Journal

Practical Action Technology challenging poverty, Kenya

www.practicalaction.org

Newsletter for rural development in dry Africa

PTC+ Practical Training Centre, the Netherlands

PTC+ is an international training institute, which focuses on all the links in the production chain on plant and animal commodities.

Training programmes are practice-oriented and mix theory with practical classes. PTC+ offers “open entry” programmes, “tailor-made” programmes and consultancy. Programmes are offered in the Netherlands and/or at location.

www.ptcplus.com

Wageningen University and Research, the Netherlands.

Various publications of the Animal Science Department about goats

www.wageningenur.nl

Useful websites:

Farmafrica.org

Snnworld/files/publications/goats

Raisinggoatsguide.com/freekeeping

Glossary

Abortion	Premature expulsion of foetus from 40 days of conception onwards.
Acaricide	Chemical product used for tick control.
Ad libitum (ad lib)	“Free access to”, often used in relation to drinking water, roughage and minerals.
Bacteria	Microscopic one-celled organisms capable of causing diseases.
Browse	Eating from trees and shrubs.
Brucellosis	Infectious disease causing abortion 2 months before expected kidding.
Buck/billy	A male goat for reproduction.
Colostrum	The first (yellow-coloured) milk produced by the goat after kidding. It is rich in nutrients, vitamins, laxatives and protective antibodies. Essential to the new-born kid(s).
Contagious disease	Infectious disease that can spread easily to other animals.
Conception	Becoming pregnant.
CP	Crude protein.
Crossbreeding	Mating animals of different breeds.
Dry goat	Nanny not producing milk.
Dry matter (DM)	Part of feed that is not water.
Dry period	Towards the end of pregnancy when a goat is not milked anymore.
Dry season	The season with very low or no rainfall.
Elephant grass	Pennisetum purpureum, also called Napier grass.
Feed Intake	Amount of feed eaten by animal.
Flushing	Provision of extra feed to encourage multiple ovulation and thus twinning.
Forage/roughage	Bulky green or dried/conserved plant materials like grasses, hay, legumes, leaves and crop residues.

Gestation	Pregnancy.
Heat	The period during which the female goat is fertile.
Hybrid vigour	Increased potential due to crossbreeding.
Incubation period	Period between being infected and disease manifestation.
Intersex	Male and female sexual characteristic in one animal, hermaphrodite or freemartin.
Kid	Young goat, between birth and puberty.
Kidding interval	The number of days between two successive kiddings.
Lactation period	The number of days of milking after giving birth (starts to produce milk) until drying off (stops producing milk).
Legume	Plants, shrubs and trees that fixate nitrogen.
ME	Metabolisable energy.
Monogastric	Animal with one stomach.
Morbidity/stunting	Arrested growth due to being diseased or underfeeding.
Mortality	Unwanted death of an animal.
NPK	Compound fertilizer containing nitrogen, phosphate and potassium.
Ovulation	Production of ova during heat period.
Protein bank	Piece of land with intensive production of legume fodder.
Quarantine	Isolation of sick or newly purchased animal.
Rumen	The first and largest of the four stomachs of a ruminant where digestion and fermentation of fibrous feed (roughage) by microorganisms takes place.
Rumination	Chewing the cud after regurgitating feed from the rumen.
Service period	Period between first detected heat and conception.
Standing heat	Period that the female is ready to accept mating by the buck.
Sterile	An animal that is unable to reproduce.

Stover	Residues of maize, sorghum or legumes after the harvest.
Uterus	Organ in the female in which the unborn kid(s) (foetus) develops, also called the womb.
Virus	Extremely small organism that causes diseases.
Vulva	External opening of the female genital leading to the vagina.
Weaning	End of the period of suckling or feeding milk to the kid.

The Agrodok series

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