

Agrodok 7

Goat keeping in the tropics

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Foreword

Agromisa's Question and Answer Service receives many questions on goat keeping. We therefore have written this practical Agrodok on goat keeping. The aim is to provide basic information for those who work directly with the small-scale goat farmers in the tropics.

It is not our intention to be comprehensive. For those who wish to know more: a number of good in-depth books are mentioned in the bibliography.

In writing this book, we made use of materials of others. We wish to thank all those who have contributed to this Agrodok. We especially wish to thank Peter Hofs of the Tropical Animal Husbandry section of the Wageningen Agricultural University for his useful comments.

We hope that this booklet will be useful and interesting for the readers.

The Authors,
Wageningen, March 1991

Foreword to the second revised edition

In this second revised edition the chapter on nutrition and feeding has been improved by Arno Overgaag, one of Agromisa's animal husbandry experts. Dr. M.N.M. Ibrahim of the Department of Animal Sciences, University of Peradeniya, Sri Lanka, reviewed the revised chapter and Robert Corner did the editing work. Barbera Oranje improved the pictures throughout the whole Agrodok. We are thankful to all of them, for their time and effort they spent on this.

We especially want to acknowledge OXFAM (UK and Ireland) in association with FARM-Africa, who have granted us permission to use some of the illustrations from their excellent publication: 'Improving Goat Production in the Tropics' (1996).

We are also grateful to ITDG Kenya and Baobab Newsletter (ALIN) who gave us permission to use an article on making salt licks.

Marg Leijdens, co-ordinator Agrodok Publications,
Wageningen, 2000

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1 Introduction - the importance of goat keeping

Goats play an important role in food production systems in developing countries. Their great popularity can be explained by their good adaptation to many different climates (ecological adaptation) and the many uses for which they can be kept.

Goats are especially important in developing countries: in 1981, 96% of the world's goat population of 496 million goats was to be found there (476 million). In those countries, goats make up 20% of the ruminants which are kept as livestock. Goats are particularly important in Africa and the Indian subcontinent (see table 1).

Table 1: Division of goats in the tropics and the subtropics
Source: Production Yearbook, Vol 33. FAO Rome

Region	Number (millions)	Percentage
Africa	144.7	41.3 %
East Asia	13.7	3.9 %
West Asia	52.7	15.1 %
Indian Sub-continent	109.8	31.4 %
Central America	10.9	3.1 %
South America	18.4	5.3 %
Total	350.2	100 %

1.1 The importance of goats

Goats are of high importance to people because of the many functions they provide: they serve as bank account which can be drawn upon when cash money is needed, kids are the interest given; they are used as gifts to strengthen relationships; they are used as sacrificial animal. Furthermore goats provide milk and meat which are high-grade food-stuffs for people.

Goats are much tougher than cattle, they are small animals and cost less per animal. Each farmer usually owns a number of goats. Goat keeping therefore touches on many people's lives.

1.2 Attractive properties

For the small-scale farmer, the goat has a number of attractive properties:

- The goat is a small animal. Compared to the big animals as cows its value is not very high. This means keeping goats is not too risky.
- It is easier to find feed for a small animal.
- Even small children can control them.
- It is a quickly maturing animal with a high fertility.
- Animals are regularly available for sale or other uses. Restoration of the herd size is also quickly done.
- Goats can maintain themselves well in poor and dry areas, where other ruminants do not succeed.
- In places where sleeping sickness is present, goats can still be kept where cows cannot survive, because there are resistant goat breeds.

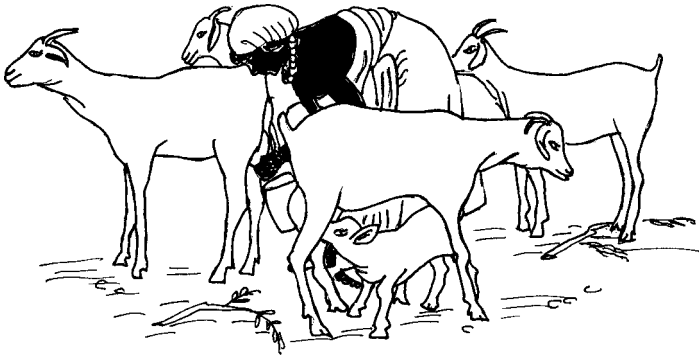


Figure 1: Woman milking her goats (Adapted from: Baobab, 1998)

2 Goat breeding

For the breeding of goats, a good reproduction is of immediate importance to the goat keeper. Good reproduction is the capability of a group of goats to produce many young in a year. Goats can have up to three litters in two years; one litter a year is usual. If more kids mature, you can sell, slaughter or give away more goats. For milking goats, giving birth to more litters also means a greater milk production.

The topics we will discuss here are:

- the sexual maturity of goat and billy-goat,
- the physical condition of both,
- being in heat,
- servicing of a goat,
- gestation (pregnancy)
- birth.

2.1 Breeding goats

In a herd, a billy-goat services a young goat as soon as she is sexually mature and the first time she is in heat (see section 2.3 - symptoms of being in heat). At that stage the young goats themselves are still growing. If they get with young, they must divide their energy between their own growth and the development of the kids growing in their womb. The milk production to raise these kids also competes with their own growth. As a result, the goat herself remains smaller and the kids born are smaller and weaker. The death among these kids will therefore be higher.

When can a young goat best be serviced?

For this you should look at the weight and not at the age of the goat. You should only let young goats be serviced when they have reached three-quarters of the normal, mature weight for that breed. With good nutrition and care, that weight will quickly be reached.

If a goat is not in good health, she will get in heat less regularly and less obviously. That makes it difficult for the goat keeper to control the mating period. To avoid this problem, it is better to first ensure that the animals are in good condition. Good nutrition and the prevention and timely treatment of disease and parasites will help.

Of course it is also important that there is sufficient feed available during the gestation and suckling period. By correctly planning the delivery date (5 months after servicing) through planning of the servicing you avoid problems.

2.2 Breeding billy-goats

After about 4 months of age, a billy-goat is sexually mature. What you should look for is that both testicles have dropped into place. If that is not the case, the sperm production will be insufficient and perhaps even nonexistent.

One billy-goat can service 10 to 20 goats. Young billy-goats should not be offered too many goats; the quality of the services will decline and the billy-goat becomes exhausted. On the other hand, if you have an exceptionally virile billy-goat then it is possible to share him with your neighbours should both of you have small herds of goats.

The same applies here: the billy-goat must be healthy and not too fat. If he is too fat, then his rutting desire will decline and the quality of his sperm will decrease.

Hornless males

In hornless breeds, so-called ‘intersexes’ can occur. These are animals which look like males but are completely infertile. They occur because their sex changes during their development in the womb. Usually they are females which become males. The female sexual organs do not develop and the male sexual organs develop incompletely; thus an infertile animal is created. Should you discover after some time that you are trying to “breed” with such a “billy-goat”, then the best solution is to slaughter the animal.

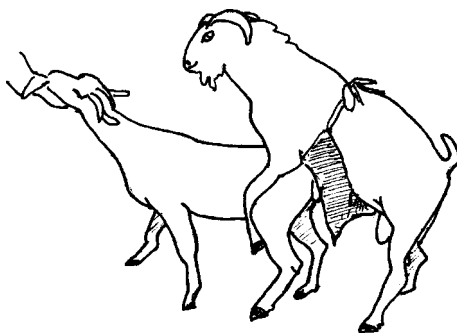
Also in breeds which normally do have horns, hornless billy-goats do sometimes occur. Even if they are fertile and produce offspring, it is better not to use them for breeding purposes as there is a chance of getting 'intersex' offspring.

2.3 Symptoms of being in heat

A healthy, sexually mature, not pregnant goat gets in heat every 17 to 21 days. She can then be serviced during 24 - 36 hours. In temperate areas there is usually a clear mating season, which is usually not the case in the tropics. A season-linked rut can occur as a result of a seasonal food shortage: alternation of a dry and a wet season with a great feed scarcity in the dry season. If such a shortage does not occur, there is no clear rutting season. If the goat keeper wants to decide himself when a goat should be serviced, he will have to look himself for the signs of being in heat:

- wagging of the tail, also when you place your hand on the loins of the goat;
- bleating, restless behaviour and jumping on the backs of other goats;
- slightly red and swollen labia (vulva);
- provocative urination in the presence of a billy-goat.

If a billy-goat is nearby, the indications are often more clear. By placing a billy-goat in the pen next to the goats you can easily see which goat wants to be covered; she will stand as close as possible to the billy-goat.



A so-called search billy-goat can indicate which goat is in heat. Walk with him past the

*Figure 2: Billy-goat with cloth to prevent impregnation of the goat
(Adapted from: Peacock, 1996)*

goats. Once you know which goat is in heat, you can offer her to the desired billy on the day chosen by you. Be careful that the search billy does not outsmart you! If you wish, you can tie a cloth around the belly of the billy-goat which catches the sperm and thus prevents impregnation.

2.4 Servicing

If the billy-goat has unrestricted access to the goats, you can usually expect kids all year round. A billy-goat which freely walks among the goats will service the goats which are in heat exactly at the right time during the heat and often several times.

For certain reasons it may be that you wish to limit the birth of kids to a certain time of the year. To achieve that, you must then also limit the servicing to a certain period.

The reasons can be:

- avoiding the merging of work peaks (kidding and harvest for example)
- avoiding an unfavourable season, in which for example too little protein-rich feed is available.

If you keep the goats and the billy-goat separate, we advise you to let a goat be serviced twelve hours after the first indications of being in heat. If you wish, you can repeat this 6 hours later. More frequent servicing is unnecessary and the quality of the sperm might decrease.

When a goat is pregnant, she will not come into heat any more. If she does get in heat again after 17 - 21 days, then the goat has not been impregnated. Pay extra attention therefore to the signs of being in heat in those goats which have been serviced after this time period. Let the goat be serviced again if necessary.

Influencing reproduction

There are a number of ways of influencing the reproduction. We will mention two systems here:

➤ *Permanently separating billy-goats and goats*

In this system, you bring the goat to the billy only at the moment she is in heat. Thus you know the exact moment at which the goat has been serviced. Determining when the goat is in heat is therefore done by the goat keeper. This task requires much awareness and is not always easy. The danger is present that you do not notice the heat or too late, with the result that you miss a mating period of the goat concerned. You must then wait 3 weeks before you can again present the goat to the billy. If this occurs regularly, the result will be fewer kids at the end of the year.

➤ *Billy-goats and goats to be serviced are kept together*

In this system, only those goats which should not be serviced are kept separate from the billy-goats. Those goats which must get with young can be kept either the whole day with the billy, or kept in the same stall only at night. The advantage of this system is that the billy-goat ensures that no period of heat is lost. The disadvantage is that you cannot be entirely certain whether a goat has been serviced and when that happened.

2.5 Gestation

Only several months after the servicing can you be entirely certain if a goat is with young. Her belly will get larger and you can feel the foetuses and see them move (right flank of the goat).

The goat has a gestation period of 145 - 150 days (21 weeks). During this period the animals must be left undisturbed as much as possible to avoid them aborting. Especially during the last six weeks of the pregnancy, you must pay extra attention to the feeding of the future mother goat. Give her your better feed (i.e. feed with plenty of protein and minerals).

Eight weeks before the birth, any milk production still remaining from the pregnant goat must be stopped. Wean the existing kids and stop milking (for milking goats). The unborn kid will then continue to

grow well and the mother will be able to produce enough milk again after the birth.

2.6 Birth

The birth is announced several days before the event by the swelling of the vulva and udder of the goat.

On the day of the birth, the goat becomes restless and will alternate between standing and lying down. She no longer drinks or eats; her udder is very tense. She sniffs at kids in her neighbourhood. The goat will isolate herself from the herd and will, for example, stand in the corner of the stall.

The vaginal secretion (a slime which protects the birth canal against infections) hangs as a long thread of slime out of the vagina. Usually the goat lies down now, but a standing birth is also possible. The contractions increase in number and intensity.

At the moment of birth the opening in the cervix and the vagina widen.

The kid is surrounded by two bladders (membranes): the inner membrane is the food bladder and around that is the water bladder. These are squeezed out first. These bladders must not be punctured as they help stretching and widen the birth openings.

Eventually the bladders burst one after the other. With a normal positioning, first the two forelegs and later the head of the kid become visible (still covered by the inner membrane). The rest of the kid's body follows in short time, being squeezed out by the continuing contractions.

Important!

In general the birth does not present any problems. Make sure that the surroundings are clean and quiet. Giving birth takes a couple of hours (sometimes less); therefore do not start pulling on the kid after a quarter of an hour! This can damage the uterus and cause infections. What you should do or have done in such a situation is described in the section below on difficult births (2.8).

2.7 Care after the birth

In general the goat is very well capable of caring for her new born kids and if the birth happens without problems, the little ones can already start grazing with the herd the day after the birth.

Still it is a good idea to keep an eye on how the birth progresses and how the young are coping. Problems may occur and your help and care might be needed.

The umbilical cord and the membranes

By the time the kid has been born, the bladders and the umbilical cord should be broken. If this has not yet happened, you must do it yourself. Break it by pulling the umbilical cord until it is constricted so much that it is cut off; do not cut it off!

The kid is wet and plastered with membranes. The mother gets to know her young and licks the young. By licking she removes the membranes and the kid can dry. If necessary help her to remove the membranes

Breathing

After this, more kids may follow. Check that the nose and mouth of the kid are not covered by a membrane or filled with mucus. If necessary remove this (with water); the animal can suffocate otherwise.

If the young animal still has difficulty breathing, you can stimulate it by very briefly immersing the head in cold water. A little salt in the water can dissolve the remaining mucus in the nose. If the animal remains listless, grasp it by its hind legs and whirl it around a few times. Although this may seem rough, it is effective; it stimulates the blood circulation and breathing.

Please note: these are exceptional situations, generally you will not have to resort to such emergency measures.

First drinking - colostrum

The healthy kid will quickly search for the teats of its mother to drink the colostrum. The colostrum is the first milk that the goat produces, and has a fundamentally different composition to that of later milk! It

is of great importance that the kid drinks quickly, a lot and often of this colostrum as the colostrum contains antibodies against diseases. In this way the kid gets its resistance to diseases. Sometimes the teats are blocked with hard plugs of colostrum; if necessary milk these out.

Navel infections

Should the kids sometimes be affected by navel infections, you can heal this (and prevent it) by disinfecting the end of the navel cord. Use for example iodine tincture, lysoform, chloramphenicol or creoline.

Cleaning the pen

During the birth, a large amount of moisture and mucus gets into the pen which should be cleaned up. Hygiene is important

The afterbirth

The afterbirth usually lets go within twelve hours and is forced out by contractions and the pull of membranes which already hang out. For two to four weeks after the birth, some fluid will still be excreted from the uterus. This is how the uterus cleans itself. The flow of fluid changes colour, from red to brown to clear. If it does not become clear and/or it stinks, then there is an infection of the uterus. The infection must be cured using antibiotics. Internal disinfection of the uterus using a salt water solution (one teaspoon of salt per litre of water) is also possible.



Figure 3: disinfecting the end of the navel cord

2.8 Difficult births

If a goat has been showing signs of wanting to give birth for a long time and she has strong, continuous contractions but no kid is being born, you must intervene. Regularly contractions exhaust the mother animal. Probably the kid is lying in such a position that it cannot come out, despite the contractions and the pressing.

The correct position of the kid in the womb which leads to a birth without problems is shown in figure 4 A. You can help the goat by turning the kid in the womb, so that it lies in a suitable position for being born. To do so, you (or better somebody who is experienced) must carefully (!) insert your hand and arm into the vagina and birth canal. Feel in what position the kid lies in the womb, the following positions can occur:

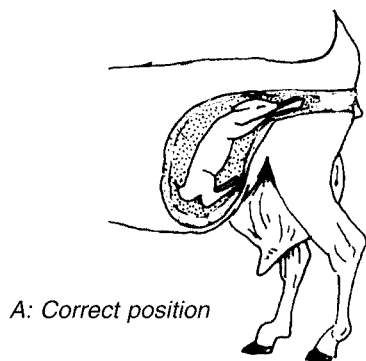
- The kid is lying with its hind legs towards the vulva (figure 4 B). It is impossible to change its position. In this case, the kid should come out backwards (breach birth); the birth should not take too long because if the navel cord breaks and the kid still has its head inside the mother goat, it may suffocate.
- The kid lies backward with folded legs (figure 4C) or the head of the kid is turned (figure 4D) . In these positions it is necessary to first carefully push the kid back towards the uterus, where there is more room to unfold folded legs or turn the head or turn the whole body.

Push in between the contractions when the goat is not squeezing. Remember also that the birth canal points down and that you must therefore never pull upwards towards the tail.

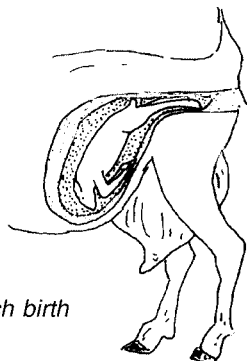
Note:

The tissue in the animal is susceptible to wounds and infections. Therefore it is important that:

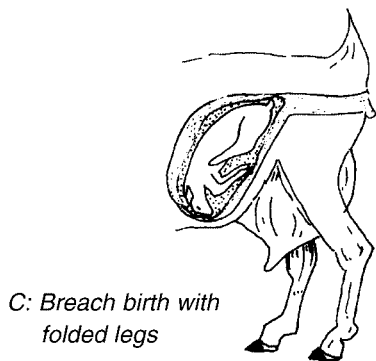
- someone with small hands does this;
- nails are cut short and are not sharp;
- all rings are taken off;
- the hand and arm to be inserted are washed well and disinfected;
- a lubricating fluid is used.



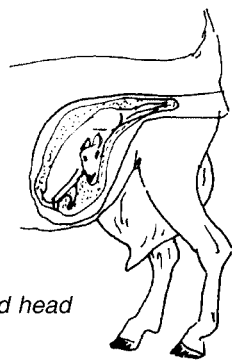
A: Correct position



B: Breach birth



C: Breach birth with folded legs



D: Turned head

Figure 4: Positions of kids in the womb

3 Raising and selection

By “raising”, we mean taking care of the newborn kids until they are sexually mature. The better the care, the greater the number of animals of good quality which will reach maturity.

3.1 Raising new born kids

Milk is the first food of the kid. The gastro-intestinal tract of the young goat is geared to properly digesting this energy- and protein-rich food. The first milk of the mother animal, the colostrum, is initially very concentrated, but 24 hours after the birth the milk already closely resembles that which is produced during the rest of the lactation. Apart from nutrients the colostrum contains antibodies which are not yet broken down in the digestive tract of the newborn kid; they are therefore absorbed as a whole through the wall of the intestine by the blood. These antibodies provide protection against certain bacteria. However, the digestive tract quickly changes and all protein is then broken down, including the antibodies. It is therefore important that the newly born animals drink the colostrum as soon as possible after birth, often and a lot. This will be no problem as the kids will find the teats themselves.

Young mother animals, or animals in poor health, sometimes have difficulty accepting their young. You can then either hold the mother still so that the young can drink, or place the young with a mother who will accept them. If the latter has also just given birth, rubbing the “orphan” in with her afterbirth can help with acceptance (scent recognition).

It is important to carefully observe the kids. You will see that one kid is much more active than the others, or grows faster. If a kid stands somewhat listlessly alone, with raised hairs on an arched back, staring straight ahead, then it has not had any milk that day. Avoid letting this go unobserved: know your kids.

Supplementary feeding

For manual (supplementary) feeding, goat's milk is best. Should no goat's milk be available, for whatever reason, give other kinds of milk. Cow's milk (if necessary made from milk-powder) is an obvious choice; you will have to give it to the kid yourself using a baby bottle or a bowl. Playing with the kid's tail, or offering it a finger to suckle, stimulates it to drink. It is also very important that the milk is at the right temperature, 40 °C. All this is no easy task but can be learned.

Cleaning the bowl or bottle very thoroughly is extremely important! Harmful bacteria quickly multiply in leftover milk and cause diarrhoea.

Fresh roughage

From several days after the birth on, the kids must have access to daily fresh roughage: grass, herbs, hay, etc. In the beginning the kids will only nibble at this food, nevertheless it is important. With this food, a kid takes in useful bacteria which ensure that the digestive tract becomes adapted to the digestion of roughage.

3.2 Weaning the young

After three months a young goat can in principle live entirely off high quality roughage, and could be separated from its mother: this is the so-called weaning. The young are then no longer allowed to stay with the goat so that they can no longer drink from their mother.

Clean drinking water must be available in the weaning period.

Early weaning is important when keeping milking goats as the milk is then available earlier for your own consumption and sale. If the rapid growth of the young goats is more important because of meat production, you can leave them a little longer with the mother goat. Do remember to wean the young goats at least two months before the next gestation period of the mother.

3.3 Caring for the young animals

Young animals need high quality feed to continue to grow well. The best grazing areas should first be for them, in some cases together with their mothers. They can then select the best parts of the plants, and there is less risk they will get a serious worm infection than if they graze with the herd. You can also separately give the animals extra, high quality feed (see Chapter 4 on Nutrition).

3.4 Selection

The reason for selecting animals is maintaining or improving the properties of a group of goats. The relevant properties for production are: reproduction, growth (meat production) and/or milk production.

A goat doing well for all properties does not exist. The goat keeper tries to get goats which are most suited to local circumstances and requirements. To achieve this, goat keepers select goats with desirable properties from the herd and use those goats for breeding. Otherwise you can buy animals from outside, in order to improve the properties of the herd.

Environmental factors

The properties of a goat are not only determined by its genetic characteristics but also by the possibilities to manifest this characteristic. The extent to which it is possible to do so is determined most by the environmental factors, such as climate, feed (quality and availability), hygiene, housing and general care. It is pointless to start selecting animals if you do not first ensure optimal environmental conditions. By doing so, you will have more rapid results than by selecting for hereditary properties.

Animal factors

Apart from the environmental factors, animal factors also influence the properties of a goat. Animal factors are: the age, the sex, being in heat or not, carrying young or giving milk, first time bearing young or having had more litters, etcetera. During selection, it is necessary to

compare those animals which live under the same conditions and which have the same set of “animal factors”.

Selection procedure

Compare the results of the goats within the group, and compare them with those of the neighbours (which keep the same kind of goats under similar circumstances). The more animals you have, the more difficult it is to weigh all the different factors and make a good choice. An important aid in doing so is a good administration of the data of each animal. For this, see Chapter 8 Administration.

Before discussing the selection process any further, we must point out never to select for one specific property only, without considering the other characteristics of a goat. This can have negative consequences.

The main selection goals:

- improvement of reproduction;
- improvement of milk yield;
- improvement of meat production (growth)

In the following sections the selection procedures for each selection goal are described. You should treat the selection procedure seriously and carefully because you gain easily by making a good start with a strong goat that will live long and that will be a good producer for a long period of time.

Before a selection for the specific production goals a first selection almost happens unnoticed: selection by judging the exterior of the goat.

3.5 Judging the exterior

When judging the exterior it is good to systematically make use of fixed criteria.

- Look for good legs.
- A deep and wide chest gives more room for the organs and indicates that they are well developed. The animal can also eat more and therefore produce more.

- Look for a good and proportional general development, a shiny at, well-placed and developed sexual organs.
- With a (milking) goat, you should look for a well-placed (between the hind legs) and developed udder, strongly veined with good large teats which point straight down.

Measurements

To objectively determine the proportions of the body, it is good to take some measurements. A goat with a good-looking colour pattern which is nice and calm, is unconsciously valued more. Some measures are the shoulder height, circumference of the chest just behind the fore-legs and the length of the back. This last measure is the distance between the highest point of the shoulder blade and the hipbone.

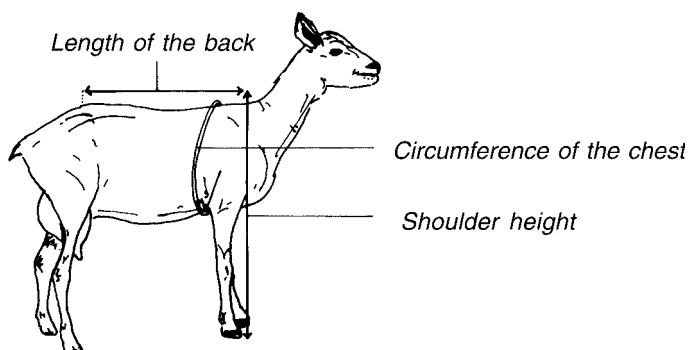


Figure 5: Judging the exterior

Judging the age of an unknown goat

When judging an unknown goat, it is useful to also be able to estimate its age. This can be done by checking the teeth: The teeth give an indication of the age of the animal and without good teeth a goat can not eat as much. Goats have 4 pairs of teeth. Up to one year of age, a goat has only small milk teeth, which are changed in the years following. The age of an animal can be determined by looking at the number of teeth the goat has changed and, in older animals, to what extent they are worn down.

At 1½ year: 1 pair has changed
 At 2 years: 2 pairs have changed
 At 2½ years: 3 pairs have changed
 At 3½ years: all 4 pairs have changed

UUU UUUU
 UU UU UU
 UUU UUUU
 UUUU UUUU

After the teeth have changed, they start wearing down. The extent of wear is an indication of the age of the animal. It also depends on the kind of feed.

3.6 Selection for reproduction

Selection for reproduction properties is important for every goat keeper. The things you must look at are the servicing results:

- how often does each goat give birth per year (time between litters)
- how many kids does are born per litter
- How many kids die and how many survive

Together this gives you:

the number of successfully weaned kids per goat per year.

Keeping reproduction records

By carefully recording the above mentioned data, you can evaluate the results of each individual goat. Your ability to judge your goats improves with the amount of data available per goat. It is best to follow the goats for two years, for example, before you draw definite conclusions. Goats which are judged not to produce well are replaced as quickly as possible. See Chapter 8 - Keeping records.

Putting the selection into practice

Goats of which the number of successfully weaned kids per year is disappointing without any clear reason, are replaced.

There are two ways of getting replacements:

- buy good goats from a reliable address (judge them on the exterior and possibly ask about their history);
- keep young from your own very best goats.

If the overall number of kids born per goat for the whole herd is low, and it cannot be due to poor conditions on the farm, then the billy goat(s) could be the cause. Try borrowing a good billy goat from a neighbour and see if the results improve.

Regularly replace the billy goat(s) with new billy goats to avoid in-breeding (once a year). Buy these billy goats preferably from other breeders of whom you know that in their selection they pay attention to those factors which are important for you.

3.7 Selection for milk production

This selection is done if you keep goats for milk production. As mentioned before, milk production is influenced by different factors. You must pay attention to optimising the environmental factors for milk production which you can influence. They are: feed, housing, hygiene and care.

Keeping records of milk production

To be able to evaluate the milk production of the goats, it is necessary to make daily notes on the milk yield per goat. This must be done consistently, otherwise the data will be of little value.

Milk production will vary over the lactation period. Normally at the start of the lactation the amount of milk per day increases rapidly. Subsequently the milk yield reaches a maximum after about 1 month after giving birth. The period during which the daily milk yield is high lasts about two months, after which it declines again. It then continues at a lower level for some three months.

The stimulation of the udder by milking or by suckling kids makes the lactation period last longer.

In tropical climates, milk yields of one to two liters of milk per day can be attained on a diet of forage.

Putting the selection into practice

In the selection, the first thing to look at is the total milk yield in the 7 months after giving birth. Compare the total milk yield of your goats and of those of other goat keepers.

You can try to improve the total milk yield by raising the peak production. This you can do by improving the nutrition or other environmental factors.

Keep the goats that produce well and use their young to replace lesser goats.

Note: of course you must also keep continue to look at the reproductive properties of the goats.

3.8 Selection for meat production

When you select goats for meat production you have to know if you or your clients prefer lean meat or fatty meat. Putting on meat takes place especially in young animals; putting on fat, on the other hand, takes place after the increase in flesh.

If fat meat is most desired, the animals are sold or slaughtered at older age, or else you can deliberately fatten the young animals.

Putting the selection into practice

Weigh all the young animals at the same age, for example at three months and at six months of age. This gives you information about the growth of each animal.

Growth can be judged in two ways:

- How rapid is the growth of the animal;
- What is the maximum weight reached (for example when they are one and half years old).

If the availability of feed is the limiting factor, you select the rapidly growing animals. A mistake which is often made, however, is that people sell or slaughter these most rapidly growing animals, when in

fact you must first select your future breeding animals from this very group.

If feed is not the limiting factor, it can be more productive to select for maximum weight achieved. Animals which grow quickest in the beginning are not necessarily those animals which reach the greatest end weight.

Selection for fatty meat

If the objective is to get fatty animals, in the first place it will be effective to fatten young animals by giving an excess of energy-rich feed. The amount of fat which has been put on can best be judged from slaughtered animals rather than from living ones. Therefore reserve the sister or brother of the animals with good results for breeding.

Castration of young billy goats

Sometimes goat keepers prefer to castrate the young billy goats which are not allowed to reproduce and which are bred for meat production. It is not necessary to castrate them and there is always a risk that castration might cause infection and cause the animal to be ill. If you still want to castrate young billy goats do this before they are three months old. It is advisable to castrate them as young as possible; the shock is then minimal. Many goat keepers prefer to castrate their billy-goats when they are 2 or 3 days old. At this age castration is a small, quick and effective treatment. In this Agrodok we can not go as far as explaining how carry out castration. We advise strongly that you seek help of a veterinary or experienced goat keeper to carry out the castration and possibly show you how to do it. Always take care that the treatment is done carefully and that hands, tools and the scrotum are cleaned thoroughly in order to prevent infection.

3.9 Cross breeding

To improve hereditary properties, use is sometimes made of crossing local goat breeds with other breeds to more rapidly achieve a certain result. However, care should be taken in doing so; the new breed may

not be well adapted to the local conditions and the end results are minimal or maybe worse. The animal with which a cross is made may be more susceptible to locally occurring diseases or need better feed than is locally available. First look at the results of others in the area around you (country, region) who have tried the same cross.

Breeding goats is an enjoyable and useful occupation, which you will get better at the more experience you have. Do not be discouraged if the first results are not those desired.

4 Nutrition and feeding

Goats are essentially browsers. They can feed themselves off trees and bushes in places where there is not enough vegetation for sheep and cattle. Their tongues and flexible top lips make it easy for them to pick leaves from between the thorns. They will even eat bark and exposed roots.

Goats can keep themselves in reasonable condition in difficult circumstances, because the first part of their stomach system. Their rumen (see figure 6 on page 30) is full of micro-organisms who help them convert poor quality fibre into usable nutrients. Their digestive system is actually an adaptation to drought. Their liking for tree leaves also means that they have an extra supply of protein, with the result that they are usually in better condition at the end of the dry season than sheep or cows who can't make such good use of tree leaves.

Despite this, if we want our goats to produce good meat quickly, or lots of kids and milk, we will have to feed them well. They will need protein in particular, which is not often available in sufficient quantity in their natural diet.

It is particularly the pregnant and milking nannies that need extra feeding. In the last month of pregnancy they will need twice as much energy and protein as normal. Don't let them start using up their body reserves, as their kids and future milk production will suffer.

Once nannies start producing milk they will continue to need quality feed. Without it they will lose weight, using up their body reserves. This means that their milk production will drop. If this happens you will probably not be able to get their milk levels up again.

4.1 Supplying the essential requirements

Water

Although goats obtain some water from the natural moisture in their food, this will rarely be enough. This is especially so during the dry

season when the feed is very dry. Dry grass or straw only contains 10 - 15 % water.

As temperatures rise, goats lose more and more body water, and their need to drink increases. If goats don't find enough water, they will eat less food and their production will drop.

In the wet tropics, on the other hand, feed can actually contain too much moisture (more than 80 %). This can result in inefficient digestion and the goats will have to eat tremendous amounts to take in sufficient nutrients.

Goats need between 3 and 8 liters of clean water per day. Milking goats need plenty of water (milk production makes all the animal's organs work at peak performance), whilst meat animals will need less. Water goats once a day and at a regular time, so that they develop a routine and learn to expect it. The temperature of the water itself is also important. The cooler it is, the less they will need and the more they will eat. So keep the water cool and change it frequently so that it does not heat up. This will also keep the water clean - this is important as goats will refuse dirty water.

Energy

Goats first and foremost need energy-giving food. They need energy to keep their body functioning and their temperature normal. They also need energy to keep active. Besides this, goats need extra energy to grow (and therefore produce meat) and to reproduce (feeding the foetus and then producing milk). See Appendix 1 for details on requirements.

Sources of energy-giving food

Energy is obtained mainly from the carbohydrates in leafy and stalky feed, in roots, tubers, bananas etc. These are normally available locally, and they form the bulk of a goat's ration.

Fat-containing plants supply 2 -3 times as much energy as carbohydrate food. There is a lot of fat (and therefore energy) in the seeds of oil crops like soya, cotton, sunflower, groundnut and coconut. Even after oil extraction, the "oil cake" that is left over is energy-rich.

Sugar is also an important energy food. It can be supplied by feeding molasses and fruit residues.

Protein

Protein is needed for growth, building up body fat, and for the essential bodily functions.

Strangely enough, the goat's minimum protein requirements are provided by its own digestive system (see below). The system provides enough to keep the goat alive, but not enough to produce good meat or lots of kids and milk. For this the goat will need extra protein and it is important that you provide this. See Appendix 1 for details on requirements.

The goat's digestive system

To understand why goats have a special need for protein it is necessary to understand how they digest their food. There are two main stages in the digestive process:

- 1 The high-fibre food or "roughage" eaten floats as a thick layer on the fluid in the goat's rumen. This fluid is home to countless microorganisms who start breaking up the coarse plant material. These microorganisms themselves live off the fibrous food that the goat eats. They need fibrous food and nutrients to function well and multiply. They live and die in the rumen, and their remains become an important source of protein for the goat.

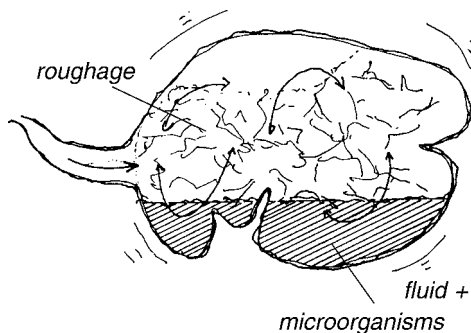


Figure 6: The goat's rumen

- 2 After the food has passed through the rumen, the rest of the digestive system starts to work on what remains to be digested - princi-

pally those nutrients that escaped the rumen process, plus the remains of dead and dying micro-organisms. This is all then absorbed into the blood, which carries the nutrients to the other parts of the body.

Sources of protein

The young leaves of vegetables, cabbages, grasses all contain protein. Shrub and tree leaves have a high protein content all the year round, especially those of pod-bearing trees (nitrogen-fixing leguminous trees like *Leucaena*, *Sesbania*, *Glyricidia*, or Pigeon pea).

Legume crops such as soya and groundnuts are very rich in protein (and fat), and this is true even for the “waste” remaining after oil extraction (soya bean meal, groundnut meal). See also Appendix 1.

The residues left after cereal and cottonseed processing (brewer’s grains, rice polishings, cottonseed meal) are also rich in protein.

Minerals

Goats cannot live without minerals. Salt, calcium, phosphorus, and trace elements like iron, copper and iodine are very important. They not only help to maintain and regulate the bodily functions, but they also strengthen the teeth and bones. They are also especially important for young kids, and for pregnant and milking nannies.

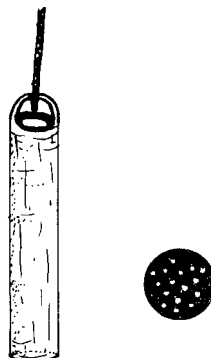
A lack of minerals will lead to a poor appetite, a dull coat, poor growth and reduced fertility. An animal will lick all kinds of objects and even try to eat them in the search for extra minerals. Remember that a goat will first draw on its own body reserves to compensate for any deficiency. This means that you may only begin to notice the problem long after it has set in. The best way to avoid mineral deficiencies is to supply as varied a diet as possible. In Appendix 3 we give a recipe of a saltlick that contains also the other minerals and which you can make with local materials.

It is also true that an excess of minerals can be harmful. Be careful therefore in your use of commercial or homemade mineral preparations.

➤ **Salt**

You can supply salt in the form of a salt lick, or inside a hanging piece of bamboo about 10 cm wide with holes in the bottom (see figure 7). It is important to protect the salt from rain, as it easily dissolves and disappears.

Milking goats need more salt, as they will lose a lot in their milk. Without salt their appetite goes down and their digestion weakens.



➤ **Calcium and phosphorus**

Calcium and phosphorus are important for the bones. Calcium is usually available in green leaves, especially those of the leguminous trees and shrubs. Phosphorus is common in seeds and cereals. Again, milking goats will need more calcium and phosphorus than non-milkers.

Figure 7: Bamboo salt lick with perforated bottom

➤ **Iron**

A lack of iron will bring on anaemia, a blood problem. It can be detected by seeing if the skin and membranes under the eyelids are pale in colour.

Plants with dark green leaves are often good iron carriers. If a goat starts eating soil it is probably looking for iron.

➤ **Iodine**

Without iodine nannies will give birth to weak, deformed or even stillborn kids. They may develop a swollen thyroid gland (goitre). Iodine shortage can be prevented by giving sea salt, or normal salt with iodine added.

Vitamins

It is difficult to generalise about the vitamin content of feeds, as there is great variation from plant to plant. Some vitamins can be produced

by the micro-organisms in the rumen. Normally an adult goat on a varied diet will not need vitamin supplements. If there really is a shortage that cannot be improved by varying the feed, vitamins and trace elements can be bought in.

Vitamin A

Generally vitamin A is the only vitamin that may be in short supply. A lack of vitamin A results in eye disorders, skin ailments (flaking and growths) and breathing and digestive problems. The birth of frail kids is also possible. Milking and pregnant goats need more vitamin A than animals raised for meat.

Vitamin A comes from carotene, a substance found in the green plant parts and in the yellow or red parts of plants like sweet potatoes and carrots. The carotene content of feed declines sharply in storage, and this explains why there is often a shortage during the dry season.

4.2 Feeding practices

Feeding practices actually depend on local conditions, the season, the types of foodstuff available, the possibilities for growing and storing fodder, and the resources available for buying in feed. There are three broad strategies possible:

1. The goats are left free to find their own food

The goats find their own food, they are browsing, grazing, or on a tether.

If the rangeland is fresh and green they should normally find enough for their needs by browsing and grazing.

Improvements

The protein quality of the rangeland may have to be improved by introducing more nutritious grasses, or legumes such as *Desmodium*.

Fodder trees can also be planted where goats graze, leguminous trees in particular with protein-rich leaves. These can also be planted in lines to form live fences (See Agrodok 16 on Agroforestry).

2. Goats are free-range, extra food is given

The goats can be left to forage free-range for part of the day but are brought in to be fed the main part of their ration. The browsing supplies some of the goats' needs, but manual feeding provides the greater part.

In the dry season free-range goats will only find dry vegetation or crop residues in the fields. These may supply some energy, but the protein content is very low. Even by cutting and carrying such foodstuffs to enclosed animals it will be hard to meet their requirements.

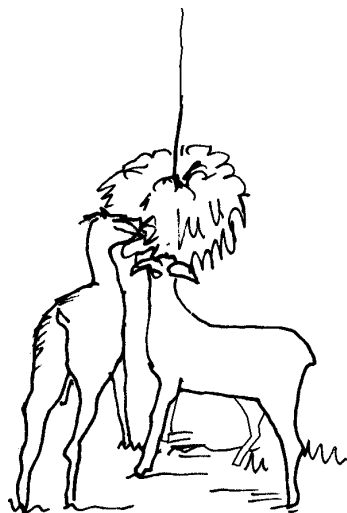
Improvements

If you can afford it, feed the goats fruits and vegetables like cassava or sweet potatoes, or the leaves of these plants. Banana peelings, and sugar cane tops are also suitable, although not so nutritious. Feed supplements will also have to be given, as explained later in this chapter. If goats are enclosed during the rains, fresh grasses, legumes, tree foliage should be cut for them. Fodder trees are useful for this. Crop thinnings or cuttings (maize, sorghum etc.) can also be fed, as well as weeds. Sweet potato vines are very nutritious.

The feed should be provided in racks or troughs to allow all the animals easy access without having to fight over the food.

A rope or net can also be used for feeding. Don't throw the feed on the ground if the goats are likely to trample on it, as it is too precious to spoil.

See also figure 18, Chapter 5.



*Figure 8: Feed on rope
(Adapted from: Peacock,
1996)*

3. Goats are completely fed manually

The goats can be kept enclosed, and are fed a complete ration in the enclosure. This means cutting or collecting food and carrying it to the animals, possibly supplemented with concentrates.

Whatever the system, stocks of hay, silage or straw/urea (see below) may have to be fed in lean periods of the year, when seasonal supplies run out.

Levels of feeding

The amount of feed a goat needs depends on:

- its size (a big goat needs more than a little one!)
- its level of activity (Is it having to spend energy foraging into shrubs, or is it being served its food in a compound or shed?)
- what it is being asked to produce (a milking nanny will need far more than a meat goat).

You can't force goats to eat, but in general the more they eat the better. Their eating habits will depend on their personal preferences, the taste and smell of the food, and the climatic conditions. If local supplies are good enough you should try to persuade (or trick!) them into eating cheaper and more easily available feed.

Combining the feeds

The priority when feeding goats is to keep the digestive system functioning properly. This means looking after the micro-organisms in the rumen, by feeding them both nutrients and “roughage” (food with a high fibre content).

Roughage

Roughage is fundamental to the well-being of the goat. Some of it is rich in nutrients as well as fibre. Fresh plant material, especially young grass or leafy green fodder, is high quality forage. It can satisfy all a goat's needs.

Most roughage however is unnutritious fibre of poor quality. This includes crop residues and dry season grasses. These will have to be supplemented with more nutritious food or concentrates.

You need to decide on how much and what to feed in the light of what is available locally. It is difficult to suggest exact proportions, as there is great variation in the type and quality of foods available, and the needs of the goats themselves will vary with local conditions. A typical method for calculating a ration is given in Appendix 1.

Hay and silage

High quality roughage can be supplied in the dry season by feeding hay or silage. This is greenstuff such as grass (or other plants) that has been cut early in growth and conserved by drying or fermenting. Hay- and silage-making are important but labour-demanding techniques. They are useful in areas where the wet season supplies plenty of grass but where the lean season can create serious fodder shortages. Hay- and silage-making procedures are described at the end of this chapter.

Hay

Hay consists of grass cut young and green and dried in the field. Hay is stacked loose or in bales, and can be saved for months, to be fed in times of food shortage. It has high nutritional value. “Standing hay” refers to the dried grass left to stand (uncut) in the fields during the dry season. It is a useful but poor-quality feed for goats.

Silage

Silage is grass that is cut and then fermented. The nutritional value is high.

Straw and urea

Straw is widely used as feed. Its nutritional quality can be improved by increasing its nitrogen content, as nitrogen makes the fibres more digestible. This is done by treating the straw with urea. The smell of ammonia from the urea may be unpleasant but it is not harmful to the animals. There is more information on urea in the following section.

Goats fed with treated straw will still need extra protein and mineral supplements. These are covered in a later section.

- A stack of straw should be treated with urea several weeks before feeding. The straw is stacked in layers, and, as each layer is laid, a mix of water and urea is poured onto each layer. Use a watering can for more even distribution.
- Every litre of water should contain 40 gram of urea.
- For every kilo of straw 0.8 liters of the water/urea mix should be poured. Make an estimation of the average weight of each layer of straw by weighing it, and then work out how many liters of water you should pour on every layer.
- Once built, the stack should be covered and sealed with a plastic sheet.
- Leave it for about three weeks, then open the stack. Leave it to ventilate, so the smell of ammonia can fade before feeding it.

4.3 Feed supplements

In the dry season, and whenever good levels of production are being aimed for, goats will probably need extra protein, energy, vitamins and minerals. There are various possibilities available for providing these.

Leguminous trees or shrubs

When the dry season sets in, trees and shrubs can provide forage long after the grass has dried. Trees in general and leguminous trees in particular (planted especially for this reason) can function as excellent ‘fodder banks’. The leaves can be cut and carried to the goats, or goats can be left to browse among the trees for a while. Browsing is not always advisable however because the trees may be damaged.

If goats are left to forage free-range for most of the day but are brought back to be fed or browse leguminous tree leaves, it is important to make sure that they are not overfed on dried grasses or crop residues. So that they keep their appetite for the green nutritious leaves.

Examples of leguminous trees: Leucaena, Propolis, Sesbania.

Industrial by-products

These consist of the residues left over at the end of food processing. They include molasses, brewers' grains, rice-bran, wheat bran, cotton-seed meal, linseed cake, groundnut cake, coconut cake, etc.. They can be important protein- and energy-rich foods in their own right.

Although they may be difficult to obtain, it is worth the effort, as these feeds are often very nutritious. A small amount of these combined with locally available feed of moderate quality can greatly improve the quality and digestibility of the ration as a whole.

Individual animals will fight over quality feed. To ensure that all the goats get their share, the best method for feeding cakes or powders is to pellet them and trail the pellets over long distances. Otherwise they could be reserved for feeding individually to pregnant and suckling animals.

Concentrates

Concentrates are food supplements fed to supply extra energy or protein. They include some of the industrial by-products mentioned above, and other products such as fish meal. They must be fed with some roughage. If concentrates are fed with too little roughage the rumen will not function well.

Concentrate foods are often part of a farming household's diet. This means that the goats may be eating into the household food budget. Before buying in concentrates for goats it is obviously important to make sure that the expense is necessary and can be justified economically.

It will often be possible to grow fodder legumes, instead of buying in concentrates.

Molasses, for energy

Molasses is a by-product of sugar making; it is a thick black sweet liquid. It has the advantage that it can be stored almost indefinitely and it can be transported far from the sugar mills.

Molasses contains high levels of sugar which is easily digested in the rumen. This makes it an important source of energy.

In addition molasses:

- is a source of minerals, of calcium and potassium especially,
- and of sulphur, an important nutrient which goats often lack.

The table below shows the proportions for mixing molasses with seed crops, to provide both energy and protein.

Table 2: proportions for mixing molasses with seed crops

Mix	Proportions	Amount per goat
Molasses + lupins	1+1	150 - 200 gm/day
Molasses + cottonseed (whole)	1+2	150 - 200 gm/day
Molasses + lupins + cotton-seed meal	1+1+0.6	approximately 300 gm/day

Protein concentrates

Protein concentrates are made either from plants or from animals. They usually come in flour form, as ‘protein meals’. They include the powdery pulp from crushed oil seeds (groundnuts, sunflower etc.). These meals raise the quality of the complete ration. They are generally quite expensive, but they are only fed in small quantities.

Poultry manure

This can also be a very useful protein source. It has good amounts of nitrogen and generally contains calcium, phosphorus and trace elements. It may pass on disease however if the poultry isn’t healthy. Poultry manure can be mixed with grain but it does not go well with molasses. Once they get used to it, goats will often eat it mixed with straw at about 5 - 10% of the total ration.

Fishmeal

If available, fishmeal is a valuable supplement.

Urea

Urea contains large quantities of nitrogen, and it is this which the micro-organisms need for their activity. Through activity they multiply and so create the goat’s protein, because their dead bodies are an im-

portant source of protein for the goat. See also the beginning of this Chapter.

Urea is therefore a useful supplement which will improve protein intake if only poor-quality roughage is available.

➤ *How to feed urea*

On no account must urea be fed on its own, as there is a real danger of urea poisoning (see below). A goat weighing 60 kg should receive no more than 10 grams of urea per day.

Because of the dangers, urea has to be provided to livestock in special ways. This could be for example:

- as a liquid molasses/urea mix
- as molasses lick blocks containing minerals and/or molasses, with 25 % urea.
- as salt licks impregnated with urea
- soaked into straw to be fed to the animals (see above).

Molasses/urea mixtures

Urea has an unpleasant taste, whilst molasses is full of sugar and very nutritious. Mixing urea with molasses is thus a very good way of getting goats to take urea. The molasses/urea mix can be fed thick or diluted:

Thick/undiluted mixture

If it is fed thick (undiluted), the urea is mixed directly with the molasses (20 - 25 % urea by weight of molasses). The mixture must be thoroughly mixed and you may have to warm up the molasses. Thorough mixing by hand may take at least 15 minutes.

Animals with free access to this mixture may overeat. They may become slightly ill at first, but they then learn to limit their intake. There is a danger that if the mixture is diluted, by rain for example, the animals may again overeat.

Diluted mixture

A “roller drum” or “bottle lick” can be set up for feeding a more dilute molasses/urea mix. This is a drum or bottle floating in a trough of molasses/urea. Goats are attracted by the molasses and lick the drum, causing it to rotate so that a fresh film of liquid appears.

This effectively gives the animals access, whilst at the same time limiting their consumption.

Table 3: 3 recipes for urea/molasses blocks. Quantities as a percentage of total weight (%)

Ingredient	Method 1	Method 2 (no lime)	Method 3 (no cement)
Molasses	50	45	50
Urea (fertiliser urea can be used)	10	10	10
CaO (quicklime or slaked lime)	5	0	10
Cement	5	15	0
(Triple) phosphate	2	0	2
Salt	5	5	5
Wheat or rice bran	23	25	23
Totals	100%	100%	100%

Molasses/urea blocks

These can be made on the farm. Cement or quicklime is used to hold the blocks together. The following table gives three possible recipes for preparing the blocks. Because of the amount of calcium in the mix, it is important to add some phosphorus as well.

- It is important to respect the quantities of lime and cement, as these are needed to hold the blocks together. Cottonseed meal can be used instead of bran - but it should not be heated up.
- Molasses quantities can be judged from the level of the drum:
a 45-gallon drum of molasses (200 liters) weighs about 270 kg.
If the molasses is too thick, warm the drum up over a small fire.
- Mix the urea into the molasses. Add the minerals, stirring all the time. The wheat bran or other ingredients, which should be dry, go

in last, as they are bulky and difficult to mix. No water should be added.

- The ingredients have to be organised in advance and establishing a routine is needed to avoid mistakes.

The key to good block making is good mixing

Urea. poisoning

If goats take too much urea their brains are affected and they develop nervous symptoms. They should be fed roughage only and the symptoms should soon disappear.

The most vulnerable animals are those that are not used to urea supplements, those with weak livers, and those taking in urea on an empty stomach.

Some possible causes of urea poisoning:

- The mixtures may have been insufficiently mixed.
- Urea-rich residues may accumulate at the bottom of containers and be eaten in high concentrations.
- Urea may leach out of blocks if they are badly stored.
- Water rich in urea may collect in hollowed out blocks and be drunk by the animals.

4.4 Hay and silage making

Hay

By rapidly drying grasses (or other leafy feeds), their moisture content can be reduced to below 20%. As long as this hay remains dry, normal rotting and decomposition cannot take place and the nutrients in the grass are “bottled up”.

In practice, the grass has to be cut just before or during its flowering period. After this period the grass is of poorer quality. If the climate allows, dry the grass where you cut it - in the field. Cut it one day and

let it dry the second day. Turn and shake it, to air it, on the third day and turn it again and harvest it on the fourth day.

In good drying weather you may need less than four days, but if you do not make sure that it is light and crisp it may rot later in storage.

An occasional shower during the drying process is not too harmful, but if you have a lot of rain you will have to use a different method: Pile the grass in small cone-shaped heaps on three-legged racks made of wood (see figure 9). When it rains the water will run off the outside layer and the inside layers should remain dry. The tripods must keep the hay off the ground so that enough air can circulate under the heap to dry it out. Leave the heaps to dry for three weeks at least.

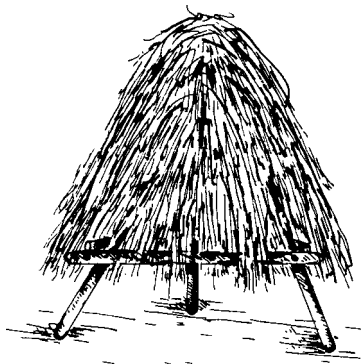


Figure 9: Hay drying on a tripod

After being dried, the hay should be stored out of the rain and sun. If stored in the open air a single large heap should be carefully constructed (a haystack). Hay that has not been properly dried will become mouldy in time.

Mouldy hay is poisonous to animals !

Good hay will always heat up a little. This is normal fermentation. Damp hay however can overheat in storage and eventually burst into flames!

Silage

Silage is fermented feed, usually young grass is ensiled but also other crops such as maize or sunflowers can be used. By making silage, feed can be stored over long periods and silage making is a much more

suitable method than hay-making for wet areas where drying is difficult.

Silage making works by making the feed acidify as quickly as possible (high acidity or low pH). This slows down the development of the bacteria responsible for rotting. Acidification is encouraged by creating conditions for harmless (lactic acid) bacteria to develop:

The cut crop must be placed in an environment where no oxygen (air) can get at it and it must contain enough sugar. Young grass can be ensiled, as can other feeds such as brewers' grains for example. Older grass or other green plants contain few freely available sugars, especially after the flower shoots have appeared. To ensile these it may be necessary to add sugar (molasses).

Making silage is labour intensive. Forward planning is essential. Silage can best be made in years of good rains.

Silage step-by-step:

➤ *The pit and digging it:*

To create an environment where no oxygen can get at the crop to be ensiled, it is best to stack the cut crop in a pit which is covered tightly after it has been filled. Before cutting your crop, dig a pit about one meter deep where water cannot flow into it. The width of the pit depends on how fast you are going to be using the silage later.

We advice to dig a pit which is narrow and long, this makes it easier later to take out some feed without the silage in the pit getting spoiled. See explanation at the end of this section.

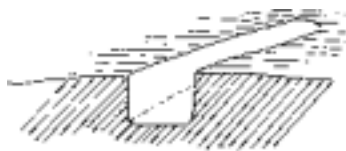


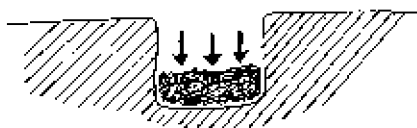
Figure 10: Narrow and long pit

➤ **The cut:**

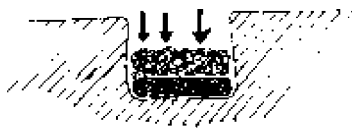
When you are ready to cut, mow the crop when it is dry, and before it flowers. Turn it, and on the next day collect it. Bruising or chopping the crop finely will improve the silage.

➤ **The stack:**

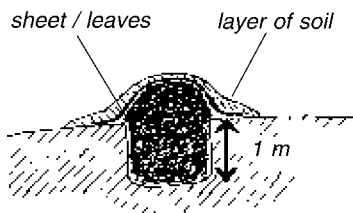
Put the cuttings in the pit in layers. If you can, spread lightly diluted molasses over them (1 - 3 kg of undiluted molasses per 100 kg of fresh cuttings). Compress each layer as it is laid - walk an animal over it so that as much air as possible is forced out of the heap. The pit should be filled and the stack should rise to about 1 meter above ground level. It will reduce in size with time. Fill the pit quickly, to avoid the start of decomposition (take two days at the most).



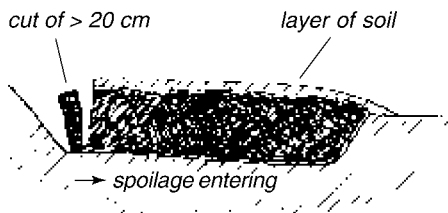
A: Putting in first layer and compressing it



B: Putting second layer on top of compressed first layer. Compressing second layer.



C: Filled pit, covered tightly



D: Opened up pit. Air can get in.

Figure 11: Silage, step by step

➤ **The cover:**

It is essential that no air enters the stack. Cover it with plastic sheet or with large leaves (banana e.g.) and then put a layer of soil on top of that (about 50 cm). Make sure you make the corners and the sides airtight, using plastic sheets and soil.

➤ *Taking out silage for feeding*

As soon as the pit is opened the air can get in. Inevitably the heap in the pit will start to spoil. The spoilage will enter the heap (from the side) at a rate of about 20 cm per day. This means that you will have to cut at least 20 cm per day to stay ahead of the rot.

If made correctly the silage can keep at least 20 years in a well covered underground pit.
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5 Housing

Goats are kept in the tropics and subtropics as well as in temperate areas. Within each climatic zone many more, smaller zones can be distinguished which can differ greatly: some are dry, others wet, sometimes this is combined with heat, 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.

In this chapter, we will look at the objectives of different housing possibilities, the different ways of housing animals and the demands you must make of a stall. At the end of the chapter, we will give you a number of practical designs which you can use as examples when designing your own stall.

5.1 Reasons for housing goats

Climate control

An important function of housing goats is to protect their health. Just like many other (domestic) animals, goats cannot take damp nor draughts well. With the help of good housing, a waterproof roof and draught-proof walls to keep out damp and draughts, you will avoid having sick goats. Goats are generally 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 shade is to be found, you must provide it yourself (a shelter).

Especially pregnant goats, nursing goats and their young are less capable of surviving unfavourable climatic conditions. You must therefore protect such animals more.

Keeping an eye on breeding, health and feeding

Good housing makes it easier to keep an eye on your goats. You can more easily observe and guide phenomena such as coming on heat, mating, pregnancy and kidding when the goats are kept in a pen than

if they wander around freely outside (see also Chapter 1 Goat breeding).

A number of disease symptoms (such as diarrhoea) can be detected earlier when the goats are kept penned. It makes a difference whether you house the goats individually or as a group. Within a group, a listless goat (caused, for example, by a severe worm infection) will be noticed sooner. A good stall has a quarantine area where you can isolate goats which are sick or probably are.

An advantage of housing is that you can give each animal individually attention and possibly better feed if necessary. For example, you can check the feeding of pregnant or nursing animals or a weakened, sick goat. Furthermore, there are certain feeding systems which make the milking of goats easier (see following sections).

Safety

Preventing theft can be another reason for building a stall. It goes almost without saying that the stall must be solidly built and should stand close to the house or compound. An alert watchdog can also help.

Especially in densely populated 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 young. A sharp watch also prevents goats from falling victim to traffic, an important cause of death among goats when there is a busy road nearby.

Collection of manure

By keeping goats inside, you concentrate their manure production and make it easier to use.

5.2 A further look at housing

There are various ways of housing goats. There are good goat keepers who only give their animals the shade and protection of a tree. There are also those who build a large stable plus milking shed.

There is no blueprint for housing; choose for yourself that form which best suits your situation. Build the stall in such a way that the goats can easily live, eat and rest there. Make sure that you can work there with pleasure.

Invest in quality

The investment in good housing may seem high at the time you calculate the cost of building a stall, but it is low in comparison with the other costs. A good stall will last a very long time and gives few problems. The really high costs are feed, labour, dead or stolen animals and caring for sick animals. Do not save on the building and good equipment of the stall without careful thought.

Individually or group housing

Whether you will house your animals individually or as a group is one of the considerations when thinking about housing. In general, goats are housed as a group because this is less labour intensive for the goat keeper and because the building costs of the stable are lower. The goat is a true herd animal and prefers group housing.

The size of the herd must not be too large in order to avoid unrest. If the goats do not graze, a surface area of one and a half to two square meters of floor space is needed per goat. If they do graze, you can get by with one square meter per goat.

Tethering animals

If you have only few animals and if you do not want to invest much in housing, the easiest way of keeping goats is to tether the goats. This means you tie each goat with a rope to a stake. A disadvantage is that the goats go round and round in circles and in doing so trample a lot of grass. You must also move them often so that they can find new pasture.

Another possibility is an exercise line (see figure 12). To make one, a long rope is stretched between two poles. The goat has a short rope about its neck which runs along the line with a ring. This system works better than the one just mentioned.

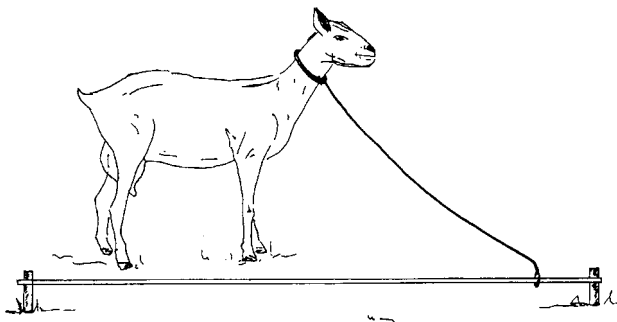


Figure 12: Goat on exercise line

Partial and permanent stalling

A distinction must be made between partial and permanent stalling of goats. In partial stalling, the goats are kept penned only at night or during part of the day; the rest of the time they wander freely, foraging about.

If you keep them permanently penned or stalled, you must also take complete care of the supply of water and feed. See section 4.2.

Partial stalling has the advantages that the stall 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 in the area. In densely populated areas with a lot of agriculture, pasture is often limited and you are usually forced to keep your goats permanently stalled.

In both partial and permanent housing, the goats are kept within an enclosure. Enclosures can be made of stone piles, stakes, thorns or wire fencing (expensive!).

Planting a hedge of quick-growing shrubs or trees, such as *Leucaena*, *Calliandra* or *Glyricidia*, is a possibility. Since goats eagerly eat such

bushes, you will initially have to protect the young plants until they are large enough to resist being browsed.

Thorn bushes which can be found locally are also suitable for making living hedges.

If certain goats continuously escape, put a triangle of wood on them. This restricts their passage.

5.3 Building stalls

A first decision is where to locate the stall. It must be near the home so that you can easily keep an eye on the goats (important in case of disease, servicing, kidding, etc.). You also discourage thieves that way.

Positioning the shed

Depending on the climate, the positioning of the shed can be important. By placing the longitudinal axis of the stall east - west, you can prevent the sun from heating the stall up 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.

The roof is also very important for good temperature regulation. A wide overhang prevents too much sun from shining in. In cooler climates, 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 up also warms up the stall.

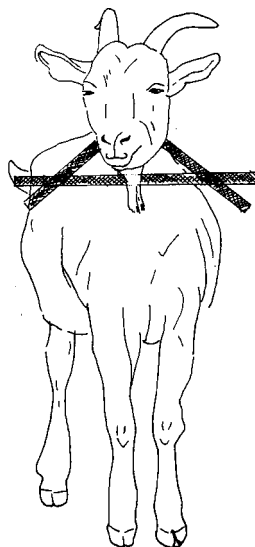
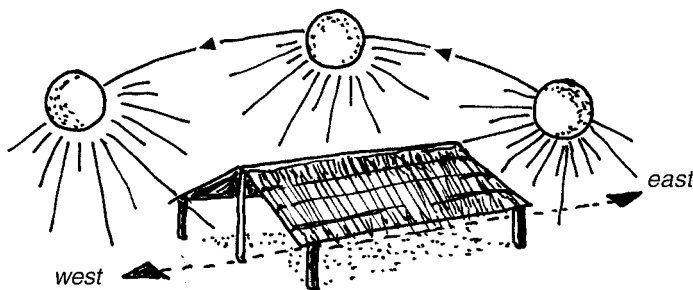
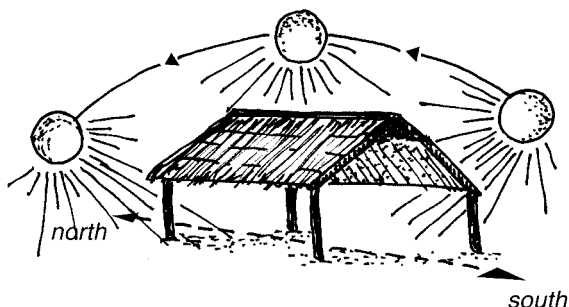


Figure 13: goat with triangle



A: Shed placed at east-west axis



B: Shed built along north-south axis

Figure 14: positioning of the shed

Ventilation

In warm climates the shed will heat up due to sunshine. Also goats radiate 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.

Good ventilation is therefore necessary. Make the shed sufficiently high and make sure there are openings for ventilation in the roof or walls.

Ventilation also provides fresh air and carries away damp air. However, please note: ventilation is good, but draughts are bad! The ventilation openings must therefore be placed high enough so that air does not blow directly past the animals (draught).

In warmer climates, where the stalls are fairly open, a low wall (of about 1 meter) on the side the wind comes from is sufficient. A hedge can also fulfil this function.

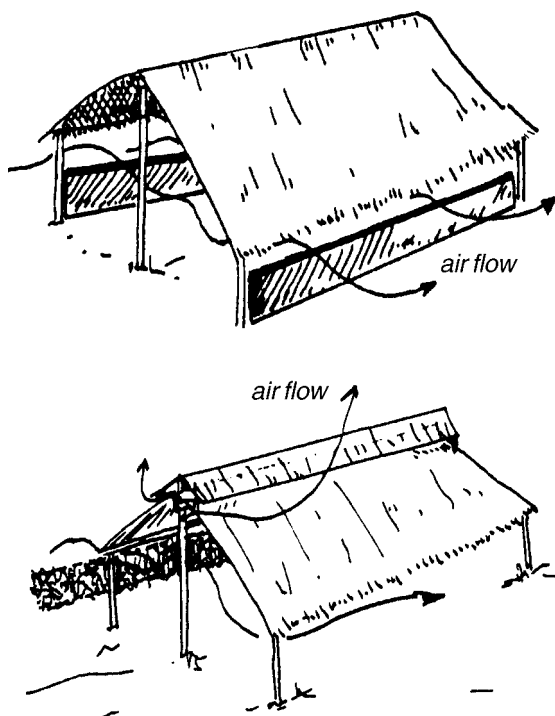


Figure 15: Ventilation in stall

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 stay 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 disease and produce poorly.

- If the foundation consists of sand, urine is absorbed well. Raking away faeces every day prevents the floor from silting up.
- A hard clay or loam floor has the advantage that it is easily cleaned.
- By making the floor slope slightly, urine will flow to one side into a drain. This can lead to another drain going around the stall which prevents rainwater from flowing into the stall.
- In the wet tropics, you can best make a grid floor using bamboo or wooden slats (see figure 16).

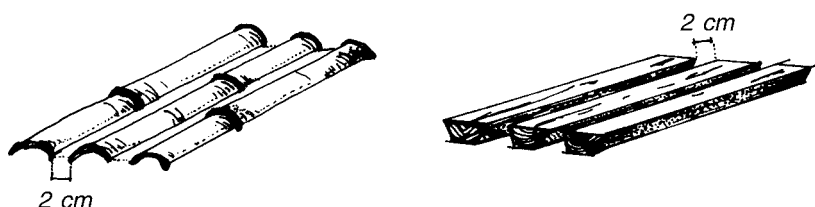


Figure 16: Two types of grid floor: Bamboo and wooden slats

You can put bedding (litter) on the floor 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 once a week so that all urine is soaked up. The mixture of bedding, urine and droppings piles up and has to be removed after some time. This mixture makes very good compost which can be used on the homegarden or field. See also Agrodok 8: *‘Preparation and use of compost’*.

On litter, however, the hooves of the animals grow very rapidly. These must therefore be cut back regularly (see Appendix 2: Hoof care).

5.4 Requirements of the installation

When talking about a shed for a group of goats, there are a number of situations in which you need to separate a goat: during kidding, raising, illness and milking. Feeding and watering also require special facilities.

- The kidding of goats can best take place in a separate pen, so that the young kids are born in clean, warm and safe surroundings. The pen must be large enough for the prospective mother plus someone who may have to take care of her. A pen of two by two meters will usually suffice.
- When raising young animals, it may sometimes be necessary to keep them apart during the first three months of their lives. 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.
- Sick animals must be removed from the herd to prevent further infection and to be better able to care for and observe them. A separate pen is ideal for this purpose.

Both the “sick-bay” as well as the kidding and raising pen 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. See next section for these feeding racks. To get good quality milk, hygiene is very important.

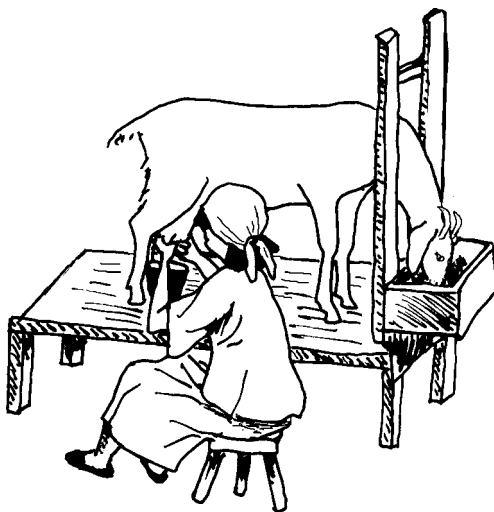


Figure 17: platform for milking with feeding rack

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.

Hence the great usefulness of 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), etc. Make sure that green fodder has been partially dried, wet feed is poorly assimilated. See also figure 8 in Section 4.2.

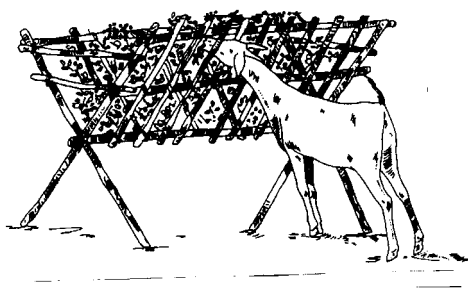


Figure 18: Goat eating from a manger (Adapted from: Peacock, 1996)

When giving high quality feed, 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 19).

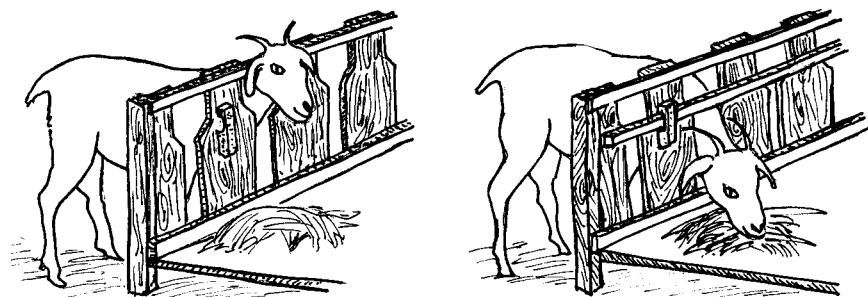


Figure 19: Feeding rack with beam

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 passage or 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 getting in it.

Watering troughs

Putting the trough on placement in order to prevent the goats from standing in it or making it dirty, is also true for the placement of watering troughs. Fencing around the troughs ensures that the goats can reach the water but cannot contaminate it.

Always make sure there is clean drinking water for the animals. On warm days a goat will use about 4 litres of water per day if it gets dry feed (see also Chapter 4 on Nutrition and Feeding).

‘Think ahead’

Also 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. If you use wood or bamboo, you will be faced with rotting, especially in the humid tropics. It is advisable to treat the wood or bamboo before use.

6 Health, disease and parasites

In this chapter, the first thing which will be explained is how you can recognize a healthy goat, followed by a section on causes of diseases and parasites which can effect the health of goats.

Prevention is better than curing

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

- A damp, windy stall will weaken the animals and make them susceptible to diseases such as lung infections.
- A filthy stall allows disease causing bacteria and parasites (worms) to grow.
- Insufficient or incorrect feeding weakens animals and can cause serious disorders (for example bloat).
- Incorrect management of pasture, whereby the goats graze too often successively on the same pasture, increases the contamination of the pasture with parasites (worms, ticks). The degree of infection with these parasites will increase.

As it is impossible to remain completely disease and parasite free, also because of the contact of animals with other animals and/or their excrement during grazing, the most commonly occurring diseases and parasites will be mentioned.

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

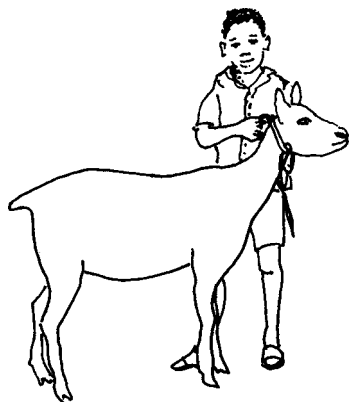
The time, money and effort you invest in keeping your animals healthy through preventive care repays itself in a healthy, productive herd. At times you have to make considerable sacrifices, for example by slaughtering sick animals with an infectious disease.

Should there be a veterinarian in the area, consult that person when in doubt about a diagnosis. He/she has more experience diagnosing diseases and often has access to medicines and facilities (laboratory).

6.1 A healthy goat

You can recognize a healthy animal by its behaviour, appearance and the proper functioning of its life 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.
- The 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 (only females).
- One of the most important life functions is the good intake and digestion of feed and water. A good intake can be judged on the basis of the eating habits of the goat, a good digestion can be seen by the dung: many round and firm droppings.
- Other life functions are good blood circulation, breathing and urination: the result of heart, lung and kidney processes. The heartbeat 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 heartbeat is raised by high production levels or in highly pregnant animals. A good functioning of the lungs can be seen by calm breathing: 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 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 high temperature (up to 39.0 °C = 102.2 °F). Among mature goats their temperature is about 38.5 °C (101.3 °F). Also during the first few hours after eating a ruminant can have a higher temperature.
- The milk production, finally, is a characteristic life function of 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.

6.2 Diagnosis of a sick goat

As we assume that you have a basically healthy herd, a sick goat will be noticed as it differs from the rest of the herd. Especially for acute (quickly developing) diseases, the symptoms are often obvious. The condition of the animal suddenly changes. Rapid intervention is necessary because acute can also mean fast declining; in that case you will lose your goat.

With chronic (long-lasting) diseases the symptoms are not as obvious. Sometimes you will only notice that a goat is getting thin 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.

6.3 Infectious diseases

Peste des petits ruminants (PPR; Small ruminants pest)

This disease, which resembles cattle pest, 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. Decomposition 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. Especially affects young animals.

- *Treatment:* preventive vaccination is best. Treatment of sick animals is too expensive but possible in an early phase. Slaughtering is better. Limit the mobility of the animals to prevent the disease from spreading. Secondary lung infection can be treated with medicines.

Contagious caprine pleuro-pneumonia (CCPP)

This form of contagious lung infection, caused by the mycoplasma (small, one-celled) *Mycoplasma mycoides* var. *Capri*, is spread by drop infection (nasal mucus). When kept permanently stalled, 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.
- *Treatment:* Preventive vaccination, arsenic preparations and antibiotics.

Pasteurellosis

Pasteurellosis, too, is a contagious lung infection, caused by two types of *Pasteurella* bacteria. Affects goats, sheep and cattle. Spreads by drop infection, usually only several animals per herd. Stress (for example during transport) stimulates the outbreak of this disease.

- *Symptoms:* see CCPP
- *Treatment:* Sulphonamides and antibiotics. Vaccination only has a limited effect. It is most effective to avoid stress by treating animals gently.

Haemorrhagic septicaemia

Caused also by *Pasteurella* bacteria (*P. multocida*). All ruminants can fall victim to it. Especially in humid lowland tropics or at the start of the wet season. Spreads through drop infection. After having passed through a number of victims, the bacteria is more virulent. 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.
- *Treatment*: There are various preventive vaccinations, to be given 1-2 months before the hot/wet season when the disease manifests itself strongly. Sulphonamides and/or antibiotics for curative use.

Foot-and-mouth disease

This viral disease affects, as the name implies, mouth and hooves of goats. The disease is transmitted by direct contact, via contaminated food, by 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, on the legs and on the liver. The goat has difficulty walking and limits its own movements. Animals do not die from the disease, but their production is stopped for a number of weeks.
- *Treatment*: Preventive 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. If there is widespread contamination, slaughter is not a realistic solution. Quarantine of sick animals, disinfection of all animals (foot baths) and immobilisation of animals at district or provincial level.

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's openings.
- *Treatment*: annual vaccination campaigns (preventive) are very effective. Antibiotics (curative) are also effective, but due to the rapid development of the disease treatment is often too late. To avoid the disease spreading, 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). Autopsy to determine cause of death to be done only by highly specialized personnel because of high risk of infection. Better when animals suddenly die to assume it is caused by Anthrax (if there is reason to suspect this) and to take the appropriate measures described.

Ecthyma

Especially in the humid tropics, this disease often occurs among goats. Usually it is not 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.
- *Treatment*: isolation of contaminated animals and frequent disinfection of the sores.

Brucellosis

This form of infectious abortion which is infrequently found among goats is especially well known as it can be transmitted to human beings. The disease is known as Malta fever. It is caused by bacteria of the type *Brucella*, in particular *Brucella melitensis*.

- *Symptoms*: abortion takes place in goats as a result of Brucellosis, but the goat is not necessarily obviously sick. The infection does, however, remain and the carrier does not get young. There is a dan-

ger that the Malta fever is transmitted to humans if they drink contaminated milk.

- *Treatment:* Vaccination is possible. Always think of 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.

Mastitis

Mastitis or udder infection is a disease found all over the world. Both acute and chronic forms are found. Bacteria of the type *Staphylococcus* and *Streptococcus* are usually the cause. In particular poor hygienic conditions in the shed and unhygienic milking promote 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 is unwilling during milking.
- *Treatment:* milk the infected udder empty as often as possible and massage it, at least seven times a day. Inject antibiotics into the udder via the teat opening and canal after milking it empty. To avoid passing on the disease, disinfect hands after milking each goat, before milking the next.

6.4 Diseases due to feeding mistakes

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

Bloat

An excessive intake of feed which quickly starts to ferment in the rumen causes a sudden accumulation of gasses in the rumen of the goat. Especially limp, recently wilted green fodder which has been heating up for some time on a heap can have this effect. Also tuber crops

which are no longer very fresh, legumes (nitrogen-fixing plants) and sour grasses can have the same effect. The important thing is that goats slowly get used to a new kind of feed. Especially when grazing, bloat occurs more the less used the animals are to fresh pasture and green forage and the juicier the green forage is, for example at the start of the wet season. Wet feed given in the stall or drinking a lot of water after eating stimulate bloat.

- *Symptoms*: The swelling of the rumen can be seen by the sudden and rapid, frequent swelling of the rear of the body, especially in the left flank. The animals do not want to eat any more and do not chew their cud. They are frightened, jumpy, breathe rapidly and become dazed when short of breath. They wobble and finally collapse, after which they often quickly die due to suffocation.
- *Treatment*: If you do not wish to let things get as far as this, then prevent the accumulation of gasses. Rapid handling is essential. 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! In serious cases, make an opening in the left flank using a trocar (thick, hollow needle) or if necessary even with a sharp knife, through the skin and the wall of the rumen. Leave the trocar or knife in the flank until the gas has escaped. Disinfect the wound.

Diarrhoea

Here, too, a sudden switch from one kind of feed to another can be the cause: 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 to this.

- *Symptoms*: Thin faeces. The animals are listless and eat little or not at all. They drink a lot; they can be feverish. Due to dehydration they can 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 excrement.

- *Treatment:* Let the animals fast for a day, keep them warm and dry. Give them unrestricted access to clean, fresh drinking water. 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 has a positive effect. Mash up some Norit and give a teaspoon twice a day.

For worms, see the next section (6.5) on parasites.

In case of Coccidiosis treat all animals with sulphonamides, treat also animals who are not (yet) sick. Coccidiosis is very contagious. Good hygiene and preventing overpopulation is the best way to avoid the disease. Allow the animals to graze in the same place only 2-3 days in a row so that they cannot take in an infectious phase of the parasite (it develops in 3-4 days in manure).

Mineral deficiencies

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 up its reserves, the deficiencies have then existed for some time. Minerals, the goats needs and how to include minerals in the feeding has been described clearly in Section 4.1.

- *Symptoms:* decreasing appetite, declining fertility, a dull coat and poor growth. The animal licks at all kinds of objects and even eats them, in an attempt to satisfy its mineral needs.
- *Treatment:* always have kitchen salt accessible for goats in the form of a salt lick or such like (described in 4.1). By giving a varied diet, you can generally avoid shortages developing. Mineral preparations are available, but use them with reserve as an excess of minerals can also be harmful.

6.5 Internal parasites: Worms

Infection with worms is common to occur. Contamination with a few parasites is unavoidable, not to worry about and can even be useful in building up resistance to those parasites. However, too many parasites weaken a goat. The goat is more susceptible to diseases and can even die. Some parasites also transmit diseases. Production and growth decline even while no symptoms of disease show. Only if the infection is severe do the animals suffer from it.

Well-fed and cared for animals suffer less from parasites.

Worms are found in the lungs, stomach, intestines and liver, and possibly other places. There are:

- Flatworms, one-segmented, these are worms with head and tail in one segment for example liver fluke
- Flatworms- consisting of multiple segments, for example tapeworm.
- Roundworms, of which only the maw worms are of importance to us.

Ways to avoid infection by worms

- Try to avoid continual grazing by many animals. Otherwise a high level of contamination of grazing areas will occur due to larva in the excrement.
- Management practices, such as rotational grazing, and regular preventive treatment of the animals against worms can prevent any damage from occurring.
- 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 mother and kids when weaning and keep the weaned kids separate from the rest of herd on as clean as possible pasture.

Please note: when treating animals with anti-worm 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 and it is sometimes better not to treat them. There is often local knowledge about medicinal plants which 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 goats 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, 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.
- *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. Treat the entire herd. Prevent infection by avoiding moist places when grazing. Ensure good drainage around the water trough. Do not use any snail-killing chemicals as they are also very poisonous for other animals !

Life cycle:

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

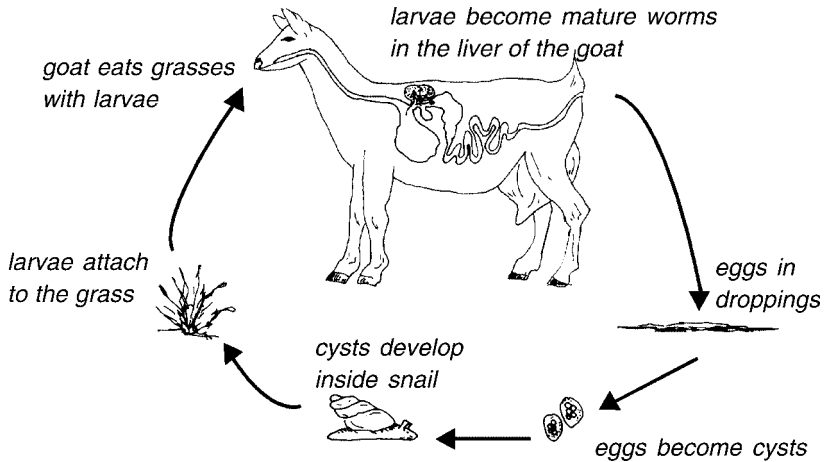


Figure 20: life cycle of liver fluke

Tapeworm (taeniasis)

Tapeworms consist of segments of about 1 to 1½ cm wide and can be several meters long. Young goats in particular are susceptible to infection by tapeworm, the mature worms are found in the small intestine. Only when the infection is severe do animals get sick, especially if they are malnourished or already have a bacterial infection.

- **Symptoms:** when heavily infected, the goat gets a rough coat, a fat stomach and anaemia. Both constipation and diarrhoea can occur. These symptoms are also found in cases of roundworm infection.
- **Treatment:** when heavy infections with mature tapeworms occur, you must treat the entire herd. Keep the animals penned for a day because with the loosening of the worms, very many eggs are also freed. Thus you prevent a new, heavy contamination of the pasture.

Life cycle:

Each segment of the worm has a complete reproductive system. The moment the segment has matured (is full of eggs), it breaks off from the mature worm and leaves the animal via the manure. The eggs are released and are taken in by an intermediate host (these are often

mites). When the intermediate host is eaten by a goat while grazing, the final worm develops inside the animal: a mature tapeworm.

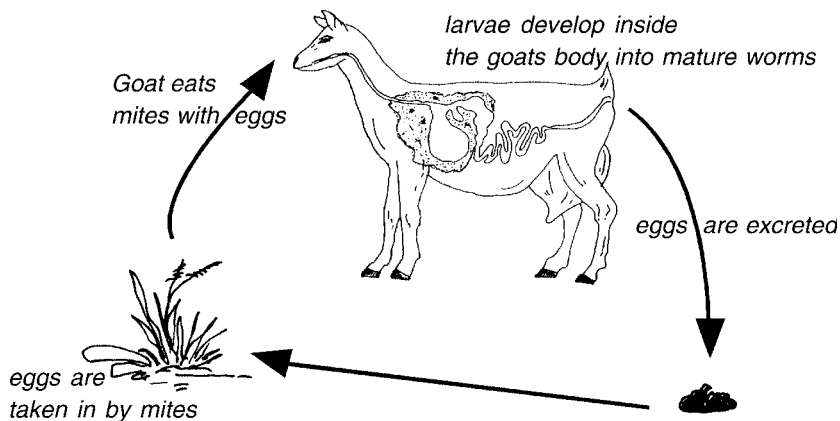


Figure 21: Life cycle of tape worm - with intermediate host

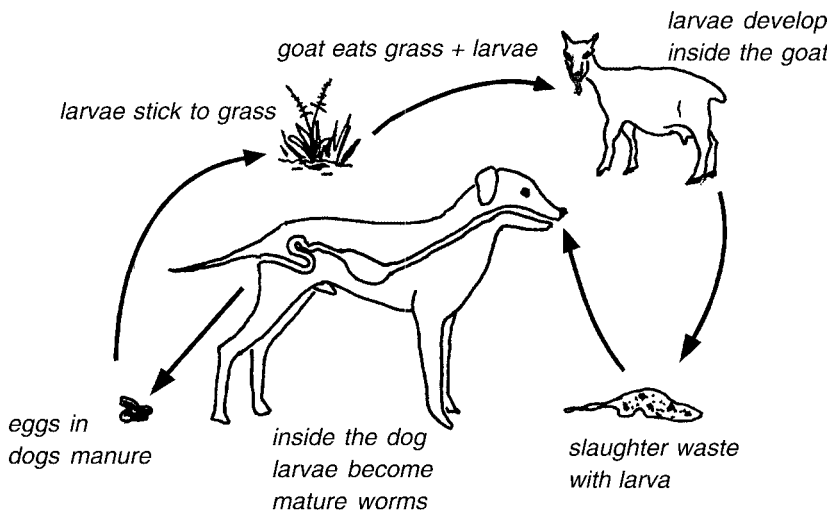


Figure 22: tapeworm life cycle with dog as main host

For other kinds of tapeworm, the goat is the intermediate host and the larva (cysts) of the worm are found in the goat. Final host is the dog

which is contaminated by eating the raw slaughter waste of goats. Tapeworms which are found in goats cannot be transmitted to human, which is possible for those tapeworms found in pigs and cattle. By properly cooking or frying meat, infection is prevented.

Roundworms

The roundworm attaches itself to the stomach or intestinal wall and lives off the tissue or blood. The larva also migrate through these tissues, therefore these worms can cause severe damage to the goats health. They cause anaemia, infections and poor functioning of the digestion.

- *Symptoms*: decreased appetite, less lively, a coarse dry coat, anaemia and diarrhoea or constipation because of too many worms.
- *Treatment*: using worm medication (depending on local availability) for the entire herd and rotation of grazing areas.

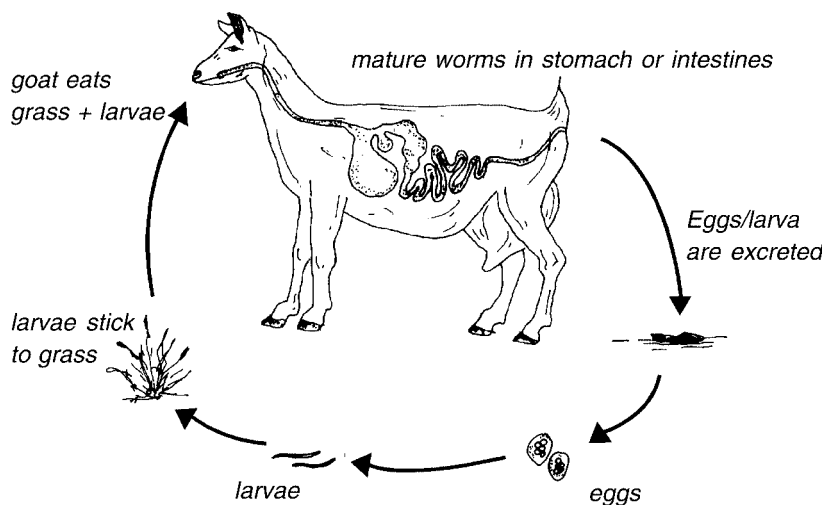


Figure 23: roundworm life cycle

Life cycle:

The mature worms are found in the stomach or intestines. Eggs or larva are excreted along with the manure, continue to develop and are

re-ingested with the grass. Upon arrival in the stomach or intestine they develop further into mature worms. Sometimes they first migrate in the intestinal tissue or to the lungs, after which they return to the intestinal tract and mature.

Lungworms

These are roundworms which are found at the mature stage in the lungs. They are less damaging than the gastro-enteric worm, but cause irritation of the bronchial tubes and possibly lung infection if there are many large worms. The eggs are coughed up, swallowed and get onto the land via the manure. Within one week there are already contagious larva which are ingested with the feed. Via the intestines and blood they get to the lungs, where they mature further.

- *Symptoms*: coughing and thinning and possibly lung infection.
- *Treatment*: see roundworms.

6.6 External parasites

Certain kinds of flies, mosquitoes, fleas, lice, mites and ticks can, at some point of their life cycle, parasitize on goats. The main complaint they cause is irritation. 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 stall is the most important measure to avoid problems. Keep the immediate surroundings of the stall free of manure and other organic waste. There are also numerous kinds of acaricide (for the mites and ticks) and insecticide (for the others) available to keep the parasites under control.

7 Goat products

As mentioned all through this Agrodok, goats have many different functions. In this chapter we will look at the goat's products, their properties and processing.

Milk is an important product when the goat is alive. Kids also are a product, they are not treated in this chapter. The slaughtering of a goat also yields various products, of which we mention the meat, blood, bones and hide. Meat, blood and milk are high-grade foodstuffs for humans because of their high protein content. Manure is a useful by-product.

7.1 Milk production and processing

In general, milk is a very nutritious drink. This is especially true for goat's milk as is easier to digest for humans than cow's milk. Milk is a healthy contribution to daily feeding, it supplies protein to the diet. Especially for children who still grow it is important to eat sufficient protein.

Some (few) people cannot tolerate milk and get diarrhoea. When taken in small amounts spread over a whole day and in combination with other kinds of food, it should give no problems. Products in which the milk has been processed and made into cheese, yoghurt or buttermilk, do not present any difficulties. See also Agrodok 36: 'Small-scale preparation of dairy products'.

The milk production process has been explained in the Chapter 3 - Raising and selection.

Stimulating milk flow

Milk is obtained by milking a goat. Milk is formed in the udder and flows from the udder tissue into the teats. The milk flow to the teats is stimulated by the presence of the kid(s) especially when the kids touch

and press the udder when sucking. Tasty feed (concentrate) also stimulates milk flow.

When milking a goat the stimulation of the milk flow in the udder can be done by cleaning of the udder or foremilk. The effect of the stimuli stop

after 5 minutes, try, therefore, to finish milking within 10 minutes.

Milking

When starting milking you first must clean the udder, after which you dry it with a clean cloth.

Hygiene is very important during milking and milk processing. Milk goes off very quickly and can be a source of infection. Partially sour milk or dirty milk is also more difficult to process.

Milking is done with the whole hand. Grasp the teat between thumb and forefinger, with the hand as much as possible against the udder. First you close the teat cavity at the top with your thumb and forefinger, after which you close your other fingers one by one so that the milk is squeezed out of the teat. Then you open you hand so that the teat cavity fills up again with milk. Milk firmly and rhythmically.



Figure 24: whole hand milking

When the milk is almost finished (the goat is done), you can withdraw the last of the milk by stroking the udder with your hand which stimulates the milk flow into the teats.

You cannot milk short teats with the whole hand; milk with only 3 fingers. If this does not work, you can pull the milk from the teat with only your thumb and forefinger: so-called stripping (see figure 26). However, this is not as good as it can be painful and the goat releases less milk. The udder tissue can also be damaged easier.



Figure 25: milking by stripping - this is no good way of milking !

Milking is best done in a special, clean and calm space. See also Section 5.4 - Milking facilities and figure 17.

Handling the milk

The milk is collected in a clean bucket, bowl or dish which can be cleaned easily. Hard materials are preferable as they do not form scratches as easily in which dirt can collect.

Again it is stressed that working hygienically is of high importance. Milk goes off easily when dirty utensils are used. Make also sure that the goats are clean before milking and especially the udder.

Filter the milk so that dirt which enters the milk during milking is removed. Try to boil the milk quickly so that the growth of bacteria is limited. Milk can be stored longer by processing the milk and making it into other products like cheese, yoghurt and buttermilk. The preservation and processing of milk is clearly explained in Agrodok no. 36: '*Small-scale preparation of dairy products*'.

Milk will quickly absorb odours and then taste bad. This is because all kinds of smells and flavours attach themselves to the fat in the milk. Avoid, therefore, the presence of a billy-goat and strong smelling feed. Strong smelling feed can also pass via the goat into the milk, but after 6 hours this effect is negligible. Therefore feed just after milking.

7.2 Slaughtering

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 is skinned.

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 out. After that, pull as much of the hide on the stomach free by hand. This prevents damage occurring 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 gullet 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 sawn 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.

7.3 Meat

One of the most important products of goats is their meat. Goat meat is less fat than sheep meat because a goat forms fat mainly around the organs and not between the muscles as a sheep does.

The meat of sexually mature billy goats has a strong odour, which may or may not be appreciated. This odour can be prevented by castrating young billy-goats. See Section 3.8 on castration of young billy goats.

Meat is difficult to keep and rapid consumption or processing is necessary. Preservation techniques much used in the tropics are salting and drying. See Agrodok 12: *'Preservation of Fish and Meat'*.

7.4 Blood

The amount of blood a goat has is about 5% of its body weight. A goat of 35 kg therefore gives about 1.75 kg of blood. Blood is high-grade food, it contains a lot of protein.

Only the blood of healthy animals is suitable for human consumption.

Just like meat, blood goes off very quickly. It must be processed or consumed quickly. It can be added to certain dishes or processed into blood pudding.

By stirring the blood with a wooden spoon, you prevent it from coagulating.

You can also use the blood for animal consumption.

Two examples:

- Mix the blood with chalk or unslaked chalk, 30 grams per litre of blood. The black, syrupy mass which is created after stirring can be kept for about one week.
- You can also dry it in the sun, which makes it possible to store it longer. In dried form, you can grind it and easily mix it with other feeds. The chalk raises the mineral content of the final product.

7.5 Bones

A large part of the carcass consists of bones, which contain the important minerals calcium (Ca) and phosphorus (P).

They can be used well in the animal feed or as fertilizer. Dried and degreased bones contain 32% Ca and 15% P and small amounts of other minerals.

If there are no handy machine available to grind the bones, then burning them is a simple way of releasing the Ca and P. By burning other components are burnt and the bones become brittle, making it easy to crush them. Both fresh and dried bones can be used. When adding it to animal feed, care should be taken not to mix it with wood-ash as this gives the feed a dusty and unpleasant taste.

The bones are burnt by piling them on a grid under which you light a fire. The grid must not be too coarse or else bones will fall through. The layer of bones must also not be too thick (not more than 30 cm) otherwise the top bones will not burn properly. After a half to a whole hour of burning, the bones are brittle enough to mash them fine.

Depending on the bones (fresh or dried), the phosphate (P_2O_5) content and the calcium oxide (CaO) content is respectively 35% and 43%. About two-thirds of the original weight of dried bones remains, and one-third of fresh bones.

7.6 Hide

Hides can be processed into all kinds of useful things.

As untreated hides rot quickly they must first be preserved to make use of them. This processing is called tanning.

As leather tanning is a complex process, we will not treat it in detail here. Detailed descriptions of tanning processes can be found in the book 'Flaying and curing of hides and skins as a rural industry' (See annex 'Literature for further reading'). Only a few simple preservation techniques such as salting and drying are mentioned here. Using those

techniques, you can store hides temporarily until you have enough to sell to a tanner.

Drying hides

Drying hides can be done in areas with low humidity and a lot of wind. A hide is dried by stretching it with strings in a frame, with the flesh (inner) side facing the sun.

Put the frame in a place where there is a lot of air circulation and make sure it cannot get be wetted by rain or dew. Bright sunlight shining directly on the hide is not good. Hang them under a shelter or with the sides facing the sun.

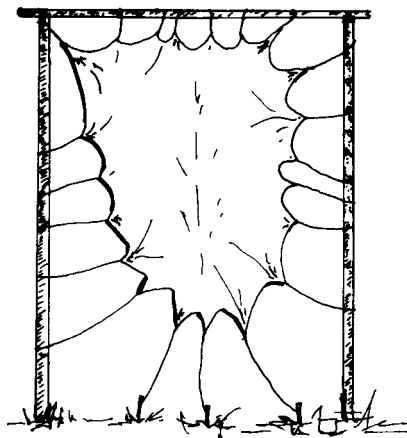


Figure 26: Hide in a frame

If wood for making a frame is scarce, you can also dry them on a rope rack with the flesh side facing the sun. Check for rotting where the hides touch the rope and in folds of the hide. Stretching them a bit with slats on the inside can help.

The disadvantage of drying is that insects can attack the hide. This is something which does not occur when salting.

Salting hides

Using salt for a first preservation of the hide is based upon the salt drawing water from the hide and slowing down the development of bacteria. Salting also prevents insect attack.

The following method is suitable in dry areas:

Wash the flesh side of the hides so that the thin layer of dried up flesh which seals the pores of the hide is removed. Remove any excess water and spread salt on the flesh side of the hide using an amount of salt

equal to 40 % to 50% of the weight of the hide. Always keep the hairy side dry!

Fold the stomach sides towards each other and also the head and tail end; the hair is on the inside. Now roll it up and store it like this.

7.7 Manure

Goat manure is a useful by-product it can be used to fertilize crops. It is a good fertilizer. It is better to compost the manure in stead of using fresh manure. See Agrodok no. 8 'Preparation and use of compost' about composting manure. Agrodok no.2 'Soil fertility management' explains about the use of manure for soil improvement.

By keeping goats penned it is much easier to collect the manure and thus increase the availability of manure.

8 Record keeping

Chapter 2 - Goat Breeding- and Chapter 3 - Raising and Selection- already indicated that a good administration is essential to be able to check the production of the business. Records of the production also enable the farmer to select goats properly and thus improve the stock.

In the first place, for a good administration you must be able to recognize your animals. If you have few goats and they have very distinct markings, then you can recognize them by those markings (make a sketch of each goat). If that is not the case, it is better to mark the goats. Possibilities are: tattooing the ear with a number; making a pattern of incisions in the ear which can be recognized; or attaching a small plate with a number.

Servicing list and kidding records

To start with, you must make a servicing list (notebook) which you keep in or near the stall and in which you record all data on kidding. In that way you can easily see if the goats kid regularly and if the number of kids born and weaned per goat is what you want. On the basis of this information, you can track down problems and use the differences between animals when selecting animals for breeding purposes.

Table 4: Example of Servicing list, when servicing is not controlled

Goat No. or name	Date giving birth	Number of kids	Sex of kids	Number weaned	Remarks
23	6 March	2	F + F	1	1 died of diarrhoea
15	15 April	1	M	1	

If you use a system of controlled servicing, then the times of servicing, the billy-goat used and the expected date of kidding (date due) can be written down. This information is useful for selecting good billy-goats.

See the next page for an example of such a list.

Table 5: Example of Servicing list, when servicing is controlled

Goat No.	Billy goat No.	Date serviced	Date giving birth		Number of kids	Sex of kids	Number weaned	Remarks
			due	real				
23	2	1st: 18/9 2nd: 8/10	4/3	6/3	2	F + F	1	1 died of diarrhoea
15	3	2/11	12/4	15/4	1	M	1	

Records on individual goats and billy goats

It is also a good idea to keep a separate record of each individual goat and billy-goat. Those records should be kept at your home and you must regularly update them using the servicing list.

Table 6: Example of an individual goat card

Goat no.: 14			date of birth: 15/8/96		Breed: Local	
No. of Father: 3			No. of Mother: 9			
Kids:						
Litter No.	Serviced by billy goat no:	Date littering	Litter size M + F	Weaned M + F	Remarks	
1	2	20/7/97	1F	1F		
2	3	30/4/98	2M	1M	1 died of Diarrhoea	
3						
Diseases:						
Remarks:						

Keeping records enables you to follow the production per goat or billy goat, also over a period of several years. You can compare the (billy) goats with others in the herd. Using the information from your records enables you to carry out a selection of (billy) goats.

On those cards you must also write down anything special, such as changes in care (feed, pen) or diseases which occurred and their treatment.

Table 7: Example of an individual billy-goat card

Billy goat no.: 2			date of birth: 27/7/ '96		Breed: Local
No. of Father: 3			No. of Mother: 8		
Offspring:					
Date serviced	goat no:	Date littering	Litter size M + F	Weaned M + F	Remarks
15/2/97	14	20/7/97	1F	1F	
8/3/97	9	12/8/97	2F	2F	1 was sick with Diarrhoea
Diseases:					
Remarks:					

Although it takes some time to set up and maintain a good administration, you will notice after a while that you do not feel lost if the production suddenly drops or you want to sell animals. On the basis of your administration, you can quickly find out what could be wrong or which animals can best be replaced.

We wish you much success and good luck!

Appendix 1: Protein and energy requirements and feed values

The protein and energy requirements are, unfortunately, expressed differently in different countries.

- The energy requirements are commonly expressed by the Metabolisable Energy (ME), expressed in Joules (MJ) (1 MegaJoule = 240 Kilo calories).

In America the 'Total Digestible Nutrients' (TDN) is used: the total amount of dry matter which can be digested. In French countries energy requirements are expressed as 'forage units' for Lactation or for Meat production, resp. UFL and UFM.

1UFL = 7.2 MJ/kg; 1 UFM= 7.7 MJ/kg; 1.05 kg TDN = 15.9 MJ ME

- The protein requirement is expressed in terms of the number of grams of Digestible Crude Protein (DCP).

In table 8 and table 9 you find respectively 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. **DCP**: Digestible Crude Protein ; **CF**: Crude Fibre

Table 8: Total energy and protein requirement and feed intake of goats of different ages and weights

Weight of goat (kg)	Growth (g/day)	Energy need (MJ/day)	Protein need (g DP/day)	DM intake (g/day)	DM intake as % of weight
10	50	3.99	23.2	414	4.1
	100	5.75	33.5	597	6.0
20	50	5.50	32.0	571	2.9
	100	7.26	42.3	755	3.8
	150	9.03	52.6	938	4.7
30	50	6.82	39.8	709	2.4
	100	8.58	50.1	983	3.0
	150	10.35	60.3	1076	3.6

Table 9: Dry matter content and feed value of several feeds (DM, CF, DCP, ME: are explained on the page before this one)

Kind of feed	DM (%)	CF (%)	DCP (g)	ME (MJ)	Quality
fodder					
young grass	18	4	25	1.9	reasonable
old grass	54	20	0	1.9	poor
good hay	85	29	50	5.8	reasonable
rice straw	90	32	6	2.0	poor
cereals					
maize	87	3	65	14.6	good
millet, sorghum	88	9	80	11.7	good
sorghum	87	2	55	13.3	good
rice, paddy	89	10	50	38.5	good
rice, husked	89	1	75	0.2	good
pulses					
field beans	87	9	205	11.8	good
chick pea	91	11	150	12.5	good
cow pea	88	5	190	12.6	good
groundnut, with shell	94	18	190	20	good
groundnut, shelled	93	3	240	28.5	good
soya bean	89	6	300	17.3	good
oils seeds and by-pro-of oil preparation					
cottonseed + husk	92	19	160	14.7	good
husked	94	3	300	20.6	good
cottonseed cake + husk	93	23	190	8.6	good
husked	92	12	350	11.0	good
sunflower seed + husk	92	27	120	17.8	good
husked	94	4	225	27.1	good
sunflower seed cake + husk	92	37	180	6.2	good
husked	94	16	355	12.1	good
groundnut cake + shell	91	22	285	9.5	good
shelled	92	6	455	13.8	good
soya flakes	91	7	410	14.0	good
coconut flakes	90	14	165	14.2	good
by-products of cereal processing					
rice meal (3-10% husk)	90	9	715	12.6	good
barley draff, wet	23	4	140	2.5	reasonable
barley draff, dry	90	15	600	10.6	good
tuber and root crops					
cassava root, dry	87	3	725	12.8	good

Example of calculating a ratio

Suppose you have a small goat of 10 kg which you want to grow 100 g a day. The feed which is available to you is cowpea and old grass.

How much of this must you give the goat?

In table 8 you see that the daily requirement for the goat is 5.75 MJ ME (energy) and 33.5 g DCP (protein). In table 9 you find the following values for the energy (ME) and protein (DCP) content of old grass and cowpea per kilogram of feed:

old grass	1.94 MJ ME	0 g DCP
cowpea	12.63 MJ ME	190 g DCP

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 $33.5/190 = 0.18$ kg (180 g) cowpea. This ration satisfies the protein requirement. At the same time, this amount of cowpea daily provides energy: $0.176 \times 12.63 = 2.22$ MJ ME.

In your case you want to provide the remaining energy, equal to 3.53 MJ, using the grass. This means the goat must eat $3.53 / 1.94 = 1.8$ kg of grass daily. That is nearly 20 % of the body weight of the animal; the goat will never manage to eat that every day! So you have to accept a slower growth or you will have to look for other energy-rich feed (e.g.: molasses, groundnut waste, beer making wastes (draff)).

E.g. you can get hold of draff cheaply: dry the draff well in the sun.

In table 9 you find for dry draff: 10.6 MJ ME per kg.

This means the goat has to eat $3.53 / 10.6 = 0.3$ kg of draff daily. This amount the goat can manage. But it might be too expensive or not available for a whole herd.

Try 250 g draff: this provides $0.25 \times 10.6 = 2.65$ MJ ME of the 3.53 MJ needed. Left to feed is: $3.53 - 2.65 = 0.9$ MJ ME.

You can provide that by feeding the old grass: $0.9 / 1.94 = 0.5$ kg

Note that the draff also provides protein: $0.25 \text{ kg} \times 600 = 150 \text{ g DCP}$.

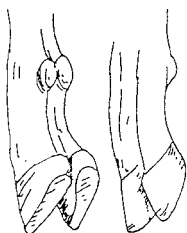
So you can leave the cow pea away and feed the goat 250 g dry draff + 500 g old grass = 750 g feed. This still is quite a lot for the goat, as a young goat manages to eat 6% of its body weight per day.

For more information we advice you the book: 'Improving goat production in the tropics' of Peacock, 1996. See the list of literature for the details. Or write to Agromisa for help on calculating a ration.

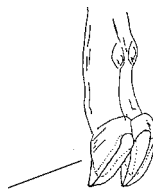
Appendix 2: Hoof Care

If goats walk a lot on soft ground or are kept penned 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 you need to do that about 4 to 6 times a year.

Healthy hooves

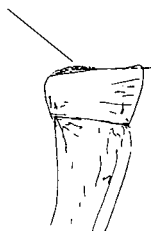


Take a knife and first remove all dirt between the hooves until you can see the sole.



Cut any crookedly grown hooves down to length. In doing so, cut the hoof (toe) down to the sole.

Bring the ball of the sole to the same height as the toe.



Hollow the sole out, if necessary, between the split between the hoof halves.

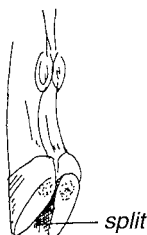


Figure 27: taking care of hooves

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.

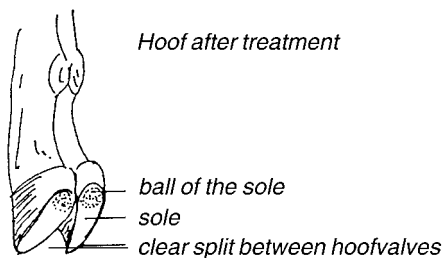


Figure 28: taking care of hooves

Appendix 3: A salt lick with local materials

With a salt lick your animals will always have salt and minerals available, they will grow better and produce more milk. To make a salt lick containing salt and other minerals you need: bones, salt and clay.

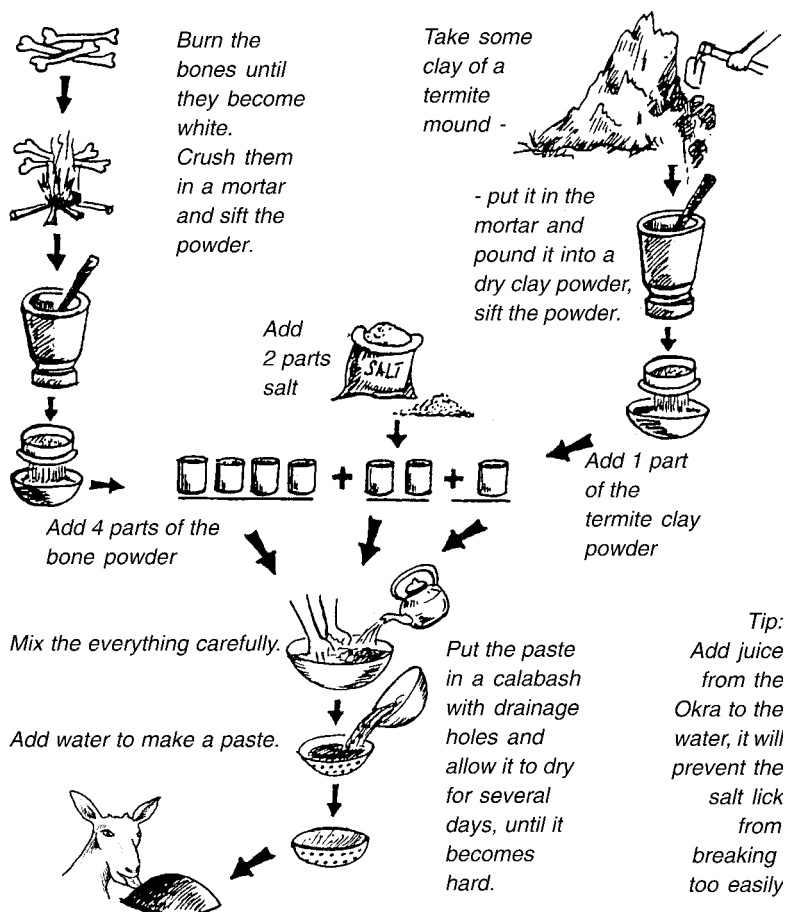


Figure 29: Source: Baobab Newsletter (Publ. by ALIN), No. 22.

Further reading

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Useful addresses

e(kika) de la gaza, Institute for goat research programs

The mission of the E (Kika) de la Garza Institute for Goat Research is to develop and transfer enhanced goat production system technologies, with impacts at local, state, regional, national, and international levels. The Institute strives to fulfill this mission through excellence in a results-driven, highly productive research program; an effective, client-oriented extension approach; and dynamic international activities that stress development and human capacity building.

Langston university: P.O.Box 730, Langston, USA

Telephone: (1) 405-466-3836;

E-mail:; web-site: www.luresext.edu/goats/

Zodiac, Animal science department, WUR

Zodiac; is the Animal science of the Wageningen University and research centre. The core-business of the department is scientific education and research in the area of animal sciences. The department aims to contribute to a sustainable animal husbandry, aquaculture and fisheries.

Marijkeweg 40, , 6700 PG, Wageningen, NL

Telephone: +31 317 48 39 52; Fax: ,+31317483962

E-mail: info@animalsciences.nl; web-site: www.zod.wau.nl/

FAO, Food and Agricultural Organization of the United Nations

FAO Animal production and health division : Mission is to clarify and facilitate the role of the livestock sub-sector in poverty reduction, improved food security, improved food safety, as well as in safe trade in livestock and Animal products while safeguarding environmental sustainability and biodiversity.

Viale delle terme di Caracalla 100, Rome, Italy

Telephone: +39 06 570 533 71; Fax: +31 06 570 55749

E-mail: FAO-HQ@fao.org;

web-site: www.fao.org/ag/AGA/AGAP/LPS

ILRI, International Livestock Research Institute

ILRI helps the world's poor people build and protect their livestock-based assets so that these, not poverty, are passed on to the next generation

P.BOX 5689, Addis Ababa, Ethiopia

Telephone: 251 14 63 215; Fax: 251 1 461 252

E-mail: ILRI-Ethiopia@cgiar.org; web-site: www.ilri.cgiar.org

International Goat Association

Publishes The Small Ruminant Research Journal

Rutland, MA01543, Rutland, USA

Telephone: 15088866729

British Goat society

Publishes a monthly journal for members.

34-36 Fore Street, Bovey Tracey, Newton Abbot, Devon TQ139 AD, Devon, UK

Fax: +44 162 6833168

Dairy goat journal

Publishes monthly newspaper obtained by subscriptions

W2997, Markert Rd, Helenville, W153137, Helenville, Uk

ITDG East Africa, Intermediate Technology Development group

A newsletter for rural development in dry Africa

P.O.Box 39493, Nairobi, Kenya

Telephone: +254 2446243/442108

E-mail: itkenya@itdg.or.ke;

Baobab newsletter

C.P.3 Dakar-Fann, Dakar, Senegal

Telephone: +22118251808

E-mail: baobab@sonatel,senet.net;

DIO, Foundation for veterinary Medicine for development cooperation.

The DIO foundation gives support and advice in the field of animal health and production to the poorer people of the world, irrespective of country of origin, beliefs or political interests. The main tool in our

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National Goat Handbook – University of Maryland,
<http://www.inform.umd.edu/EdRes/Topic/AgrEnv/ndd/goat>

Maryland Small Ruminant Page

<http://www.sheepandgoat.com>