Climate Smart Technologies and Management Practices for a Profitable Goat Enterprise in Uganda







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ABBREVIATIONS/ACRONYMS

%	Percentage
οC	Centigrade
٥F	Fahrenheit
AI	Artificial Insemination
CAE	Caprine Arthritis Encephalitis
CCPP	Contagious Caprine Pleuro-Pneumonia
cm	centimeter
DDA	Dairy Development Authority
DOB	Date of birth
DV	Daily Value
ECA	Eastern and Central African
FMD	Foot-and-mouth disease
GDP	Gross Domestic Product
gm	gram
ha	hectare
IFTS	Indigenous fodder trees and shrubs
IPM	Integrated pest management
IU	international unit
kca	kilocalories
kg	kilogramme
MAAIF	Ministry of Agricultural Animal Industry and Fisheries
PPR	Peste des Petits Ruminants
ROI	investment ratio
UBOS	Uganda Bureau of Statistics
UShs	Uganda shillings
μg	microgram
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FOREWORD

Popularly known as a "**Common Man's Cow'**, goats are among the main meat-producing animals in Uganda. Its meat (chevon) is one of the choicest meats which has huge domestic demand in Uganda. Goats are important in resource-poor communities because they provide tangible benefits such as cash income from animal sales; meat and milk for home consumption and/or for sale, manure, skins and fiber. Considering the high rate of youth unemployment in Uganda, rearing goats is a profitable business for youth.

The information in this manual is a review of published work on goat production. The manual covers reproduction, health, feeding, management, processing, marketing and diversified aspects. In this way, it is hoped that this manual shall be helpful for the development and extension of goat farming business in Uganda, as it is useful as reference to farmers, youth and stakeholders of this business to set up own business.

Some of the pictures were provided by Engineer Michael Musasizi, a young goat farmer and owner of JM GRINTA FARM, Busunju, Mityana district.

SECTION 1: INTRODUCTION

1.1. Agriculture sector potential in Uganda

Agriculture is the backbone of Uganda's economy, employing over 60 percent of the population, and contributing half of Uganda's export earnings and a quarter of the country's gross domestic product (GDP). Since most Ugandans live in rural areas and practice farming, raising agriculture incomes – a centrepiece of Uganda's National Development Plan – is critical to reducing poverty, boosting prosperity and creating jobs, especially for women and youth.

1.2. The contribution of livestock to household livelihoods in Uganda

According to 2021 data from the Ministry of Agricultural Animal Industry and Fisheries (MAAIF) and the Uganda Bureau of Statistics (UBOS), Uganda currently has about 14.2 million cattle, 16 million goats, 4.5 million sheep, 47.6 million poultry and 4.1 million pigs. The livestock subsector accounts for about 17 percent of agricultural value added and 4.3 percent of Gross Domestic Product. The livestock sector contributes between 1 and 1.5 percent to Uganda's export trade value.

Over 60 percent of households in Uganda depend on livestock for their livelihoods. Most of them are subsistence-oriented smallholders. Households that include livestock in their enterprise mix tend to be less poor. Livestock provide a wide spectrum of benefits, such as cash income, food, insurance and savings, draft power, energy, and social capital.



They contribute to crop production through provision of manure, which improves soil fertility, soil structure, and water-holding capacity. Livestock farming is considered more dependable than crop farming. For example, small ruminants, with their high rates of reproduction and growth, can provide a regular source of income from sales. Integrating livestock into a farm system can increase its economic and environmental health and diversity, thereby making important contributions to the farm's sustainability.

SECTION 2: SUSTAINABLE GOAT PRODUCTION

2.1. Role of goats in Uganda

Raising goats can be a valuable part of a sustainable farm. Goats often fit well into the biological and economic niches on a farm that otherwise go untapped. Goats can be incorporated into existing grazing operations with sheep and cattle, and they can also be used to control weeds and brush to help make use of a pasture's diversity.

Goats play an important role in the food and nutritional security of the rural poor especially in the rain-fed regions where crop production is uncertain, and rearing large ruminants is restricted by acute scarcity of feed and fodder. Goats are multi-functional animals. Farmers can produce them for meat and for milk but there are a wide variety of products which can be got from goats, such as manure and skins, among others.

Goat farming in Uganda is becoming popular because the cost of goats is relatively low compared to cattle. Many families are taking goat production as a family business venture and revenue stream. Goats have a high multiplication rate because they produce twice a year and the Savanna goats in Uganda have become the preferred exotic breed since it is believed that they are hardier than Boer goats.

2.1.1. Advantages of starting goat farming business

- Goats have been considered as poor man's cow (**mini cow**) for the poor people because of its immense contribution in rural economy and national income.
- Starting a goat farming business requires low initial investment or capital.
- Commercial goat farming is a key source of employment particularly for the youths.
- Goats do not require large area for housing because their body size is comparatively smaller than other livestock animals.
- Goats are versatile animals that are raised for a variety of reasons such as meat, milk, cheese, yoghurt and hides.
- You can use goat manure as a high quality natural fertilizer in crop field. This will directly help to maximize crop production.
- Goats are good breeders and they reach sexual maturity within 7 to 12 months of age and give birth to kids within a short time. Some goat breeds produce 2 to 3 kids per kidding.
- Risks are less for goat farming (even in drought prone areas) than any other livestock farming business.
- Goats are called the "foster mother of humans" because their milk is considered as the best milk for human consumption than any other species of livestock animal's milk. Goat milk is nutritious, wholesome and easily digestible. All people from child to old one can easily digest goat's milk. Goat milk also has lesser allergic problems. Goat meat and milk are cholesterol free and easily digestible.
- Goat milk is suitable for preparing various types of milk products which provide a great source of regular income (employment) for the poor, landless and marginal farmers, youth and women.
- Meat and milk from goats are in high demand on the market. There are no religious restrictions on goat products, and they are widely consumed.
- Goats are very suitable for mixed farming with other domestic animals.
- Diseases are less in goats than other domestic animals.
- Goats are easily available, comparatively cheaper in price, easy to maintain and always have a friendly disposition than cattle.
- They are capable of adopting themselves with almost all types of agro-climatic environments or conditions. They can tolerate high and low temperature.
- Some goat breeds are popular for meat production, while others are suitable for milk production, and yet others are suitable for both meat and milk production.

- According to the investment per unit they produce more than other domestic animals. The ROI (return of investment) ratio is very good.
- Goat business requires less labour and you can easily use your family labour for raising goats.
- Goats require less feed because they are smaller animals. In Uganda, there are several goat varieties that can thrive on low-quality feed as well.

2.1.2. Socio-economic factors affecting goat production

Some of the major socio-economic factors affecting goat production are:

- Diseases and pests
- Inadequate (quality and quantity) feed due to land shortage
- Poor breeds
- Predators
- Shortage of water
- Shortage and/or high cost of labour
- Poor transport
- Theft
- Lack of good markets
- Poor quality/high cost of inputs
- Climate change (floods and drought)
- Lack of expertise regarding how to efficiently run a goat farming business due to lack of veterinary services.
- Lack of capital
- In some areas of Uganda, women and children participate less in decision making, although they are responsible for many goat production related activities.

2.2. Goat production systems

Goats can be kept in multiple production systems, depending on availability of land, capital and labour. These include (a) intensive, (b) semi-intensive, and (c) extensive production systems.

2.2.1. Intensive (zero-grazing) goat production system

The intensive system, also known as zero-grazing is a system where the goats are housed. Feed and water are provided to the goats. Intensive farming is a technique used to yield high productivity by keeping large numbers of improved goats indoors, it is an agricultural system that aims to get maximum yield from the available land. The bucks, does, and kids are kept in different compartments or houses. In the intensive system, mating is controlled, where the farmer can decide which bucks and does mate and the time for mating. This ensures that there is no cross-breeding and flock multiplication is controlled.

2.2.1.1. Advantages of intensive grazing goat production system

- Intensive grazing systems does not need a large amount of land and no grazing pastures.
- Can use agricultural by-products such as sweet potato vines, banana leaves, maize, maize thinnings, bean husks and others.
- Saves time and labour, do not have to take goats out of the crop fields for grazing or spend time looking for them
- Less death amongst the kids because they can be easily monitored throughout the day
- Easier to plan and manage breeding.
- Prevents goats from destroying crop fields.
- Makes collecting manure very easy.
- It helps the farmer to supervise and monitor the land and protect his goats from being hurt or hounded by dangerous wild animals.

2.2.1.2. Disadvantages of intensive goat production system

- Intensive goat farming system requires a lot of labour and capital
- It involves the use of various kinds of chemical fertilizers, pesticides, and insecticides.
- The use of chemical fertilizers contaminates soil and water bodies such as lakes and rivers.
- Heavy use of pesticides and chemical fertilizers can also affect the workers (who spray the pesticides) and the people residing nearby.
- It can lead to overcrowding due to the fact that animals are kept in holding facilities which can lead to pollution and break out of diseases and infection.

2.2.2. Semi-intensive system

Semi-intensive goat production system is a mixture of both intensive and extensive systems. The goats are left to graze and also are provided with feed and water. In some cases, the male goats are zero grazed, while the does (female goats) are grazed. The does are brought to the bucks for mating.

2.2.2.1. Advantages of semi-intensive grazing goat production system

- Easy access for feeding, watering and good protection.
- Low investments and higher returns, significant savings in feed costs, better meat quality, the meat being lean and fat free compared to intensive system.

2.2.2.2. Disadvantages of semi- intensive goat production system

• The need for high quality litter.

2.2.3. Extensive goat production system

Extensive systems are characterized by large areas to feed the animals, with a low animal density. The system uses soils of poor agricultural ability, located in mountainous areas with large rainfall or in areas of low rainfall, sometimes with extreme temperatures. The goat production in this extensive system uses family labour or often as a second source of income for families. Goat milk is obtained for family consumption or for cheese to sale.

2.2.3.1. Advantages of extensive goat production system

- Although extensive production is not very productive, it is of great importance regarding the maintenance of the rural landscape and with the aim of the biomass management that avoids the occurrence of forest fires, and where the goats are well adapted to take advantage of these feed resources.
- The goat production in this extensive system uses family labour, often as a second source of income for families. Goat milk is obtained for family consumption or for cheese to sale.

2.4.3.2. Disadvantages of extensive goat production system

 Usually, the number of animals produced is low and they are usually raised under climate adversities, where probably there are no shelters, no food supplementation and also often these animals have hygienic sanitary problems, which leads to poor economic results.

2.3. Important tips for a commercial goat farming business plan

Though, goat farming is not a new enterprise. It is becoming very popular day by day due to its high demand and good economic prospects. Commercial goat farming is a great business idea with good returns of investment ratio (ROI). For starting and maintaining a profitable business, you must have to make a proper and effective **goat farming business plan** and go according to the plan. This involves (not in order of importance):

(a) Practical experience is more important than book knowledge

Having training on goat farming system before starting commercial goat business is highly recommended. Learning from existing farmers is a very good option. Goat management skills and experience of available staff and of veterinary personnel are important.

(b) Select a very good farm area/location

You must ensure that your selected location has all types of facilities for goats. The necessary facilities for goat farming business include the following:

- Source of fresh and clean water supply.
- Availability of required equipment.
- Easily available feed source.
- Fertile field for crops, pastures (grasses and forage legumes) and other green fodder species. Feeding green fodder keeps the animal healthy, productive and reduces feeding costs.
- Availability of full time labour.
- Good transportation and veterinary service.
- A market near the farm land so that you can sell your products easily and buy necessary commodities.

The acreage needed is determined by the number of goats being raised. To raise 500 goats, about 10 acres of land, including shed construction area, is often necessary. If you want to begin with a small number of goats, say 50, you'll need 1 acre of land.

(c) Fixed capital and circulating or working capital

Fixed capital is required for putting up farm structures like housing, fencing and equipment. Circulating capital is required to finance the production cycle e.g. purchase inputs such as feed supplements, drugs, equipment, forage seed, fertilizers, irrigation equipment, building materials, fencing. Returns on initial capital are very important. Goats kept at commercial and medium scale and milking goats have higher returns to capital than small-scale enterprise.

(d) Choose the products you want to produce

First, determine whether goat meat or milk has a great demand in your local area. Then, depending on the demand, you should start a commercial dairy goat farm. If your location has sufficient facility for marketing your products internationally, then you can establish goat farm for producing any types of products. But for commercial purposes, you must establish meat or dairy goat farm which will give you more profit.

(e) Choose the right goat breed

There are different types of goat breeds available for rearing in the goat farm. Some of the available goat breeds are famous for tasty and nutritious meat and some breeds are famous for milk production. Dairy goats are raised mainly for commercial milk production or for family milk consumption.

(f) Construct a shelter or housing for your goats

Housing is an important factor for profitable goat farming business. Small-scale farmers generally keep their goats with their other livestock animals. But for commercial production, a good goat housing system is highly recommended. A good house not only gives shelter and protects the goats from predators but also prevents them from bad weather and various types of goat diseases. Always keep the house neat, clean and dry. Make proper ventilation and drainage system inside the house. Also ensure availability of sufficient fresh air and light inside the house. Housing and goat farm design are of various types according to the production type and breed.

(g) Nutrition and feeding

Most of the goats in Uganda are fed on maintenance rations due to lack of planned objectives. The current production systems are low input, low output type i.e. low productivity types. There is need to invest into providing balanced feed rations to achieve targets for instance attaining a particular weight at a certain age through feed supplements etc.

Goats prefer to eat grasses, plants, shrubs, weeds and herbs. Besides those feeds, goats need energy, protein, minerals, vitamins, fiber and water for proper growth and for making better profits from this business. It is recommended to have sufficient knowledge about what to feed goats. Goat farmers need a balanced feed ration for healthy growth and high-quality milk and wool yields. The following is an example.

- High quality pastures are a must for commercial goat farming business. Pastures help to decrease complementary food cost. Browsing in the pasture helps to keep the goats healthy.
- Silage (green fodder from home grown crops) in the amount of kg/goat should be fed twice a day, 1 kg in the morning and 1 kg in the evening.
- Feed any leguminous/grain fodder weighing 500-600 grams/goat once a day.
- A concentrate of 200-250 grams/goat/day should be fed once a day.
- Provide mineral blocks all the times.
- Provide clean water throughout the day

(h) Breeding

In any commercial goat farming operation, the choice of goat breed is the key source of profit and loss. Select goats that are capable of multiple kidding and have a short gestation period. One male goat is required for every 20-25 female goats. Bring a healthy and robust male for breeding purposes.

In today's time, various modern farmers are using artificial insemination system for breeding in commercial goat farming. It is very suitable for large scale commercial goat farming. If you have just started up with few goats then you must use natural goat breeding.

(i) Fattening

If commercial goat farming is designed for meat production, a fattening method should be considered in order to make quick money from the sale of those goats. In the fattening system, 3 to 4 month old male goat kids are selected and given a zero grazing diet for 6 to 7 months before being sold in the market for mutton at the age of 9 to 10 months. This will assist goat producers in rotating their funds or expanding their operations.

(j) Care and management

Always take good care of your goats. Never feed them on contaminated food or polluted water. Keep their house clean. Keep kids, bucks and does separated for each other. Take extra care to the breeding bucks, kids and pregnant does. Keep the kids with their mother for several weeks after their birth. Avoid using same buck for mating with numerous does at same day. Artificial insemination is a great way for breeding your does.

(k) Fencing

Make a fence around your farm area. It will keep your goats safe and free from other harmful animals like dogs. You can make a fence with general wire or electric wire

(I) Veterinary services

The health of goats plays vital role to generate a good and profitable business. Though, diseases are less in goats. Be sure of the availability of proper and sufficient veterinary service in your farm. You must store the necessary drugs and vaccines in your farm so that if the animals are affected with diseases, then you will be able to provide first aid.

(m)Marketing

Marketing is the most important but easiest step of goat farming business. Goat products like meat and milk have a huge local demand and popularity. You can easily sell your products in your nearest market. Commercial producers can target international market and export the products in foreign countries.

(n) Total expenditure and profit

Total expenditure and profit from goat farming business depends on the farming system, location, breeds, feeding cost and other factors. With good planning and proper management you can easily make goat farming business profitable. Small-scale farming requires less investment and profit can contribute your regular income. On the other hand, large scale or commercial production require high investment and some other additional costs.

SECTION 3: COMMON GOAT BREEDS IN UGANDA

When selecting goats, it is important to consider the environment that they will have to live in, and if they are suited to such environment. There is a high demand for the supply of goat meat and milk in Uganda but the major constraints to adequate supply of these two products are the scarcity of suitable breeds and poor nutrition. There are many breeds of goats, large and small breeds, specialised in dairy and meat. A few of the common goat breeds in Uganda are described below:

3.1. The Savanna goats

The most profitable goats at the moment are the white savanna goats. Savanna (also called "Savannah") goats originated in South Africa by breeding Boer goats with local landrace goats. Savannas were selected for strong jaws, long-lasting teeth, and sound legs so they could stand on their hind legs to efficiently browse brush, leaves, and any other green thing in their harsh environment. They were developed to be a low-input meat goat, able to adapt to rough climates and poor forage. The white savanna goat offers more opportunities because of its niche Arabian market, especially for its meat. They were also specifically developed for their rare white hair and dark skin.



Savana goat breed

Savanna goat meat

Does average 50-100 kgs, while bucks weigh about 90 kgs or more under good management. Savannas easily endure heat, intense sunshine, cold and rain. Savanna goats can be raised and live like other small-farm meat goats, with about 250 feet of pasture space per goat for exercise and social needs. In such a setting, high quality fodder and mineral supplements must be provided for the goats, and breeding is typically controlled.

3.2. Saanen

The Saneen originates from Switzerland, but at present is widely spread in many parts of Uganda. The Saneen coat is all white or all cream and the hair is generally short and fairly fine although some may have longer hair along the spine, hindquarters, or both. Horns may or may not be present at birth. The ears are generally pointed and erect and the head is usually lightly structured.

The Saanen is a typical dairy-type animal. Saanen does are heavy milk producers and usually yield between 3 and 4 percent fat. If well fed, a Saanen can produce more than 3 litres/day of milk, making it good for milk and milk products businesses. Saanens have a dished or straight facial line and a wedge-shaped body. Saanens are of medium height when compared with the other breeds. The breed is sensitive to excessive sunlight and performs best in cooler conditions. The provision of shade is essential, and tan skin is preferable. Saanens are usually very docile animals and like to keep to a routine so are well-suited to machine milking. They respond quickly to affection.



Saanen goat

Saanen doe

The high-producing Saanen doe should be an efficient reproducer. She should have a docile nature, and appear alert and feminine. The udder should be well developed not fleshy, and have a collapsed appearance and a soft texture after milking. It should be round or globular, and not pendulous or 'split' between the halves. A fairly flat udder sole is preferable. The udder should be carried high and well under the body. Good udder attachment is particularly important. The teats should be distinct from the udder and moderately sized.



Well-developed Saanen udder

They should be squarely placed and point slightly forward. Does with abnormal teats and udders may prove difficult to milk and should not be used for breeding replacements. The jaw should be square (not overshot or undershot) and the teeth should be sound. The muzzle and nostrils should be wide, the lips broad and the eyes set well apart. The neck should be long, slim, of good depth and connect evenly with the withers and shoulders.

Saanen does can grow up to 63-77kg whereas the male, 80-100kgs of live body weight. They have no horns and have higher chances of producing 2 kids per birth. It is important to note that a Saanen does not prefer hot areas. This breed is known for it is intersex/free martin offspring, therefore horned animals are preferred, but they may be dehorned.

The Saanen buck

The Saanen buck's ability should be gauged by his reproductive performance and the quality and performance of his offspring. The buck should have good conformation and depth of body, be masculine but not coarse in appearance and have vigour.



Saanen buck

The testicles should be of good size, well balanced and firm. The scrotum should be well placed, not divided and allow the testes to hang away from the body (not excessively). Polled bucks are not generally used in breeding programs as offspring resulting from matings with polled does may be born as either intersex females or sterile males. If polled bucks are used, they should only be mated with horned does.

3.3. Anglo-Nubian

The Anglo-Nubian goat has been bred from crosses of English, Indian, Egyptian and other goats. The colours vary, but brown and white dominate. The Anglo-Nubian is a relatively large and graceful dairy goat.



Anglo-Nubian

Anglo-Nubian kid

The Anglo-Nubian goat is named for Nubia, in north-eastern Africa. The breed is an allpurpose goat, useful for meat, milk and hide production. A useful characteristic is that the milk is very concentrated (4 to 5 percent butterfat content). It is the best suited of the dairy goat breeds to hot conditions. The Anglo Nubian has been used in grading-up programs in many tropical countries to increase milk and meat production of local breeds. The udder of the Anglo-Nubian is capacious but is sometimes more pendulous than that of the Swiss breeds. A mature doe should weigh over 50 kgs, while the males should weigh over 70 kgs.

3.4. Toggenburg

Toggenburg breed is imported from South Africa, Kenya and other countries. Colour varies from deep chocolate brown to pale fawn and the coat is generally short and fine though longer coats are common. Toggenburgs have white or cream markings on various parts of their body.



Toggenburg goats

These markings may fade with age. Horns and tassels may or may not be present at birth. The ears are erect and point slightly forward. The muzzle is generally broad.

The Toggenburg doe

The does weigh about 55 kg. Toggenburgs do not generally produce as much milk (2-3 litres of milk per day) as the Saanen breed but have consistently good udders and are known for their persistent milk production over long periods.



Toggenburg doe

Butterfat content 3 to 4%. The udder should be well developed, not fleshy, and have a collapsed appearance and a soft texture after milking. It should be round or globular, but not pendulous or 'split' between the halves. The udder should be carried high and well under the body. Good udder attachment is particularly important. The teats should be distinct from the udder and moderately sized. They should be squarely placed and point slightly forward. Does with abnormal teats and udders may prove difficult to milk and should not be used for breeding replacements.

The jaw should be square (not overshot or undershot) and the teeth should be sound. The muzzle and nostrils should be wide, the lips broad and the eyes set well apart. The neck should be long, slim, of good depth and connect evenly with the withers and shoulders.

The Toggenburg buck

The Toggenburg buck's ability should be gauged by his reproductive performance and the quality and performance of his offspring. The buck should have good conformation and depth of body, be masculine but not coarse in appearance, and have vigour. He should be strong though not heavily boned, and have good firm legs.



Toggenburg buck

The testicles should be of good size, well balanced and firm. The scrotum should be well placed, not divided, and allows the testes to hang away from the body (not excessively). Polled bucks are not generally used in breeding programs as offspring resulting from matings with polled does may be born as either intersex females or sterile males. If polled bucks are used, they should be mated only with horned does.

3.5. Alpine

The French-Alpine is a breed of goat that originates from the Alp region in Europe. The breed has good potential for both milk and meat production.



Alpine goats

The milk of Alpine goat is a good source of calcium, niacin and vitamin A. The animals have a good size and an enormous variety of colour of their coat, from black to white. Their weight is 60 kg and 65 kg respectively for females and males. Alpine goats are hardy, adaptable

animals that thrive in any climate while maintaining good health and excellent production. Alpine goat gives 1 to 3 kids at a time and birth of twinning is common.

3.6. Boer goat

This breed is the result of long selection of local goats in South Africa. The colour is almost always white (with a brown neck and a black or brown head).



Boar goat

They are characteristically white with chest-nut red head and white main body. The horns are prominently rounded and set well apart, growing with a gradual backward curve. The head is strong with large eyes. Ears are visibly broad, drooping and medium length. The coat is soft, smooth and glossy while the hairs are short to medium in length.

Boer goats are excellent meat producers and produce good quality skin. The animals have a good fertility and are well muscled. The females are ready to start kidding by eight months and can kid 3 times in two years. They have high reproductive rates of 7% triplets and 50% twins. They can be very heavy with males weighing up to 130 kg and females 80 kg. They are mainly kept for meat production, but have also a reasonable potential for milk which is often used for suckling the fast growing kids.

3.7. Local or indigenous breeds

These hardy breeds are commonly referred to as local or indigenous breeds in Uganda. They are characteristically slow in growth, have a low twinning rate (less than 30% chance of twinning) and yield little milk in comparison to exotic goats. They are, however, more resilient to environmental harshness and have shown marked resistance to some disease spreading parasites. They are reared for their meat and good quality skin. The Mubende goat breed is probably the biggest of the common local breeds.

(a) The Mubende goat

The Mubende goat breed is commonly found in the central region, the north and north-west of Lake Victoria. It is predominant in the former greater Mubende district.



Mubende goats

It is the largest local goat breed with a live weight of 30-35kgs in males and 25-30kgs in females. The breed has glossy fur with short straight hairs. The skins sell highly on the world market. This breed has shiny, straight hair that is normally black or a mixture of black and white. Its meat is of high quality, as is its skin, which is used as leather in the tanning industry. Adult males weight 25 - 35 kg, and females weigh 22 to 28 kg. It has a high twinning rate.

(b) Kigezi breed

Kigezi goats are found mainly in south-western Uganda with some in Ankole and other bordering regions. The colour of this goat is black and the hair is long. Average live weight for adult males is 28.8 kg, castrates 30.0 kg and females 30.3 kg. It is smaller than the Mubende goat, weighing 25-30kgs at maturity. They are characterised by a black and grey coat.



Kigezi goat breed

(c) The Small East African goat

The Small East African is the name given to a type of goat which is found throughout Eastern Africa from Zimbabwe and Malawi in the South through Tanzania to a large part of Kenya and Uganda. These goats are predominantly kept for meat. They grow slowly, but have a heavy-set conformation and are resistant to heart water (a tick-borne disease) and worms and possibly other diseases such as mange.



The Small East African goat

The hides give a good quality leather. An adult weighs between 25- 30kg and the age for first kidding is 18 months.

(c) Karamoja goat

This breed is adapted from the Karamoja region. It is suitable for the arid areas of Kotido, Moroto, Abim and Nakasongola districts. It is a short-haired, mainly white breed. It is a relative of the Galla goat breed of Kenya.



Karamoja goat

3.8. Crossing exotic with local goats

When a farmer crosses an exotic with a local breed, the kids will be 50% (100%/2). If the kids (50%) are again crossed with a local, then those kids born will be 25% (50%/2) If the kids (50%) are again crossed with the pure exotic breed, then the kids born will be (100%+50%=150%/2=75%). Gradually, you can build your stock into the pure bred using the formulae above. It is also important to note that crossed goats are more resilient to diseases compared to pure breeds.

SECTION 4: GOAT HOUSING

Suitable goat housing or shelter is very important for goat farming business. Goats need a house like other domestic animals for staying at night, security and protecting them from adverse weather. Some people keep their goats with other domestic animals such as cows. In some areas, people keep their goats under trees. But if you want to establish a profitable commercial goat farm, then you must build a suitable house for your goats. Before building house for goats, the following tips very important.

4.1.Features of a good goat shed

- The goat housing area must be high enough to keep the goats safe from floods.
- Must have bright lighting and proper ventilation.
- Ensure that the floor is strong enough to hold the goats.
- Try to make the wall of the house with concrete or by using timber poles.
- The house must be comfortable.
- Accessible to food and clean water.
- It must have a space for storing feed, straw and other equipment required for goat farming business.
- If you are using wooden floors, the floor should be fitted together. This protects the goats from injury.
- Goat shelter sizes depend on the size of the herd or of the animals themselves.
- The house must have the facilities of cleaning well regularly.
- Goats are affected by extreme cold. So take extra care in rainy season. Otherwise they may caught by Pneumonia.
- A good goat house must provide protection from cold
- It should also provide protection against predators and thieves.
- Goats should stay outside as much as they can. They love the sun on their faces and the breeze in their beards. They only use their goat shelter to get out of the rain, snow, or wind.
- Pole barns and sheds are good for goat shelter because they're usually pre-built with lumber and screws, and sometimes floors. If you need space to milk and take care of baby goats all year round, then it would probably be wise to build goat housing that will last years.

4.2. Cheap materials for constructing a goat house

The materials you will need for the construction of a goat house will depend on the type of goat housing system you desire. In general, you will have to mix one or more these materials below to achieve what you want.

- (a) Bamboo This is good for making the flow of the shed. You can also use bamboo to cover the sides of the goat shed.
- (b) Nails You need nails for holding woods together and for fastening roofing materials over the shed.
- (c) Straws This provides bedding for the goats, absorbs uring and faeces and provides a more comfortable area on which goats can walk.
- (d) Roofing materials For roofing the goat shelter.
- (e) Hammer For driving in nails.
- (f) Sacks of jute To cover shed from cold weather
- (g) Fencing materials To make a wall fencing the shed.
- (h) Hardwood For making poles.
- (i) Blocks For securing the shelter
- (j) Cement for making concrete shelter

4.3.Types of goat houses

There are three main types of goat housing construction systems you can choose from for commercial goat farming.

- 1. Goat housing construction on the ground
- 2. Construction of goat housing on poles
- 3. Concrete goat house

1. Construction of goat house on the ground

Construction of goat shed on the ground is generally the most common house for goats. You can make the floor with bricks and cement or simply with soil.



It will be better, if you can spread some dry straw over the floor in this housing system. But you must have to keep the house dry and clean always.

2. Goat housing over poles

For starters, this is probably the best type of goat shed you can think of because it is cheaper than concrete houses. Constructing goat houses on poles keep the goats free from damping conditions, flood water. To build this type of goat shelter, you need strong poles on which the shed will balance. The poles and floor in this housing system are usually made with bamboo or wood. The floor of the house heights about 1 to 1.5 meters from the ground. This type of house keeps the goat free from damping condition, flood water etc.



The poles and floor in this housing system are usually made with timber or bamboo. This type of house is very suitable for goat farming, because it is very easy to clean. And you can easily clean the closet and urine of goat form the house. Diseases are also less in this housing system.

3. Concrete goat house

If you want something long term, then go for concrete goat sheds. This type of goat house is fully made with concrete, and slightly expensive. But concrete house has many advantages. It is very easy to clean the house, and easy to always keep your goats safe from all types of predators. You can construct the house over ground or over concrete poles. Both types are easily maintained. Diseases are less in this housing system.

4.4. How to construct a goat shelter

4.4.1. Required space for goats

- Every adult goat needs about 0.75 meter x 4.5 meter x 4.8 meter housing space. Every billy goat needs 2.4 meter x 1.8 meter housing space. It will be better, if you can keep the nursing and pregnant goats separately.
- A house of 1.8 meter x 1.8 meter x 2.5 meter is suitable enough for housing 10 small goats.
- You can extend or decrease the area of goat house according to the number of goats in your farm. But keep in mind that, every goat needs their required space for proper growing and better production (Table 1).

Table 1: Chart of required space for goats according to their age and nature

Goat	Required Space (Square meter)
Baby Goat	0.3
Adult Goat	1.5
Pregnant Goat	1.9
Billy Goat	2.8

While building house for your goats, emphasis should be on the comfort of your goats. Ensure that, your goats are living happily inside their house, and the house is suitable enough to keep them free from adverse weather and all types of predators.

4.4.2. Flooring

Gravel floors are the best option for goats although some people prefer wood. The dirt in the gravel absorbs urine and when the gravel is covered with straw, it helps keep the goats warm. Sheds with mud floor may be suitable except in places where high rainfall is observed such as central and western Uganda. Farmers should therefore avoid concrete flooring because it is cold and hard on the goats' bodies even though it is easier to clean. Farmers should also remember to keep the floor of the shelter always dry because dampness can be a breeding place for various diseases among your goats. The shelter should be constructed in an elevated area or slightly slanting to prevent water and urine stagnation. This also helps with drainage in your shed which should be good, to counteract any build-up of smells and urine.

4.4.3. Bedding

Regardless of type of floor, you need to use some sort of bedding for warmth and comfort. If you have to use a concrete floor, make sure to put down three to four inches of saw dust to insulate the goats with enough warmth while they sleep. Goats can be deep littered, with the bedding being topped up regularly then being mucked out completely every month. You need about 20 square feet per goat for sleeping space.

4.4.4. Kidding place

If you plan to breed your own goats, you will need kidding enclosures and the number of cages you will need depends on how many goats are kidding at a time. The kids may be left with their mother for the first three days but afterwards isolated into a special cage where they are bound to receive special attention. The same place should have bedding for the kids. Also, regardless of the breed, you need an area for doing routine care, such as hoof trimming or clipping. If you are keeping dairy goats, you can use the same space for milking.

4.4.5. Feeding facilities

Goats are ruminants with four stomachs, so they eat throughout the day in order to keep food moving through their systems. Water, minerals, fodder and concentrates are the key components to feeding goats.

• Supply a bucket of fresh water, a mineral block and a feeding trough full of fresh fodder, hay, pellets and other roughage. Plastic basins, drums or pails can serve the purpose. Place this outside of the pen to avoid contamination with urine or manure.





Simple water (left) and feed (right) troughs at JM GRINTA FARM, Busunju, Mityana district

- A feeding trough keeps the feed off the ground so it doesn't get wet and helps reduce waste. Elevate the feeder 1 1/2 ft above the floor and attach it to the goat house from outside.
- A bamboo tube with 2 or more slits at the bottom can serve as mineral salt container for the ordinary table salt for the goats to lick. Hang the bamboo tube inside the house.
- Store the fodder/forage in hay rack under a shade or shed adjacent to the goat house.

4.5.6. Fencing as a good practice in livestock management

Goats are notorious for getting out of enclosures, so you will need some tight shelter to protect them from bad climate but also a considerably strong fencing for them. Fencing is important for the safety and health of your goats. Fencing for goats needs to be secure, not just to keep them in, but to keep predators like dogs out.



JM GRINTA goat farm in Busunju

You will need perimeter fencing around the entire goat area or your property boundary, and then cross fencing within the goat area to keep goats separated from each other. Fences are being used successfully to contain all breeds of goats in many environments. They are one of the first improvements intending goat owners should consider for without good fencing goats will roam. This not only upsets neighbours, but also disrupts stock breeding programs. Effective for disease control, as immediate isolation of sick animals in a herd can be easily done. Breeding herds can be isolated from none breeding stock, especially among stud breeders, in order to avoid inbreeding of closely related animals.

4.5.7. Biosafety measures for healthy goat business

Biosafety (biological safety and well-being) is the management practice that prevents infectious diseases from being carried into a herd or onto a premises. The goal of a **Biosafety** program is to prevent the transmission of disease-causing agents to animals by direct or indirect means. There are three simple rules when allowing visitors and workers to wear their own footwear in your production areas:

- Check all visitors and workers boots.
- Clean footwear with a brush to remove debris, and then wash with water to remove all visible plant material and soil.
- Disinfect footwear using a **footbath** containing a strong disinfectant. You could also use a spray bottle to treat shoes with a disinfecting solution. Be sure to follow the use instructions on the product label.

SECTION 5: FEEDING MANAGEMENT OF GOATS

Among all the ruminants, goats are only the animals which can eat and consume almost all types of food. Proper nutrition is the cornerstone of a healthy goat herd. Goats' feeding requirements and diet preferences are different from other ruminants such as sheep and cattle. A goat's diet should center on fresh forage and/or good quality hay. Goats that have a higher energy need will greatly benefit from the addition of concentrates or grain as a supplement to their diet. Other important management practices such as maintaining an appropriate stocking density (number of animals per acre), preventing disease, and minimizing stressors are also crucial for a healthy herd. Work with your veterinarian to design a feeding strategy that works for your goat.

5.1. Factors affecting amount of fodder a goat will consume

- If good quality forage is available, the goat will eat more and refuse very little, but if the feed is of low quality, the refusal rate will be high as will the wastage.
- For dairy goats, if the forage quality is low, milk production will be reduced drastically. This has a negative impact on the performance of the goat and its offspring.
- Zero grazed goats eat more fodder than goats on free range.
- It is always advisable to chop fodder to reduce waste and make it more palatable.
- A-45 kg dairy goat in milk should consume up to 7% of its body weight in dry matter daily and plenty of clean water.

5.2. Major types of feed resources for goats in Uganda

5.2.1. Definitions

- **Pastures:** areas of land covered by grasses and legumes (forage crops) for livestock to graze on. They are a valuable source of feed for grazing animals, as well as a way to improve soil health and provide protection against erosion. Grasses and legumes in pastures can be grazed by cattle, sheep, goats, horses, and other animals.
- **Forage crops:** grasses, legumes or other forage plants that are grown to provide feed for livestock. The crops can be harvested and fed to the animals in a barn, or the animals can be allowed to graze directly on the field. Forage crops are an important part of the feed supply for cattle, sheep, and goats.
- **Fodder:** feed given to the animals (including plants cut and carried to them), rather than that which they forage for themselves (called forage). Fodder includes hay, straw, silage, compressed and pelleted feeds, oils and mixed rations, and sprouted grains and legumes (such as bean sprouts, fresh malt, or spent malt).
- **Concentrates** refer to animal feeds that are rich in energy and/or protein but low in fiber, such as corn, soybean meal, oats, wheat, molasses, etc.

5.3. Pastures

It is very necessary to make a pasture for your goats, where they can browse freely and eat food from there. By browsing pasture, your goats will remain healthy and will get sufficient and necessary food elements like energy and protein. Natural feeds from pasture also helps the goats increasing the tastiness and digestibility of other foods. A pasture with natural plants and grasses like millet, Sudan grasses, Bahia grasses, grain grass mixture, clover, sorghum etc. are very healthy and effective for goat production and health. In pasture if the goats can browse freely then it will help them to keep free from various internal and external parasitical diseases.

5.3.1. Natural pastures

Natural pastures consist of grasses and legumes are harvested from public land, roadsides and swamps and their availability vary across seasons. Natural pastures in most parts of Uganda are of poor quality. Such pastures cannot sustain satisfactory levels of production and health of improved goats for most of the year.

Natural pastures grow rapidly during the rains and set seed before the dry season. Consequently, goats gain body weight during the rainy season and lose it during the dry season. The seasonal gain and loss in weight of animals results in poor growth pattern accompanied by low reproductive performance. In many instances the goats have to rely heavily on crop by-products for survival until the next rainy season. In order to ensure better performance of goats, the use of high nutritive planted/improved pastures are required.

5.3.2. Planted/improved pastures

Meat and dairy goats must depend almost solely on improved pastures to meet their nutritional needs if they are to be economically viable. Pastures commonly utilized are grasses, legumes, browse, weeds, hay, and silage. With rare exception, these plants contain usable protein, energy, minerals and vitamins in useful measure. It should be emphasized that goats actually prefer to browse on brush rather than on grass, commonly taking about 60% browse and 40% grass in mixed plant populations. Since goats are particularly adept at selecting the most nutritious plants (and within plants, the most nutritious portions), they may do reasonably well on grazing areas considered poor to fair by man and cow alike if, of course, the amount of herbage is adequate. Like other animals, however, goats respond quite favourably to increased quality/quantity of feedstuffs.

5.3.2.1. Pasture grasses

Elephant grass (*Pennisetum purpureum*) fodder is the most popular pasture grass for stall-fed goats in Uganda. However, the quick maturing characteristic of elephant grass during the dry season leads to a decline in its nutritive quality (less than 7% crude protein). New high yielding Napier grass varieties have been introduced in Uganda. These include Pakchong 1 Super Napier introduced by The Green Elephant Uganda; and 79 Napier x Sugar introduced from Kenya Agricultural and Livestock Research Organisation by the National Livestock Resources Research Institute





79 Napier x Sugar variety

Pakchong 1 Super Napier field

Other examples of pasture grasses are: *Cynodon dactylon* (Bermuda grass - Oluchwamba); *Chloris gayana* (Rhodes grass – Orunyankokore); *Panicum maximum* (Guinea grass – Mukonzikonzi); Brachiaria spp. (Signal grass – Kifuuta/Ejubwe) and; *Setaria anceps* (Dogs tail – Kakirakambwa/obuterante).

Pakchong 1 Super Napier

Super Napier is a Hybrid Napier grass obtained by crossing Elephant Grass and Pearl Millet. The grass was introduced into Uganda from Thailand in 2015 by The Green Elephant Ltd.

Why Pakchong 1?

- Pakchong 1 Super Napier is the only variety giving highest crude protein (16-18%)
- Pakchong1 Super Napier can produce 100 to 200 tons of fodder per acre per year (depending on the management, soil fertility and climate) which makes it as "King of Napiers" in worldwide
- It lowers your cost of dairy farming and increases milk and meat yield because of its high protein content (18%).
- It is the fastest growing napier variety. The first cut is taken from 75 to 90 days after planting and subsequent cuts are taken after intervals of 30 to 45 days.
- It is easier to plant and take care of, it does well in almost every part of Uganda. 8.





Rhodes grass

Bermuda grass



Guinea grass



Setaria grass



Signal grass

5.3.2.2. Pasture legumes

Pasture legumes form an important source of feed for goats and have potential to provide a sustainable solution for feed and protein security. Legumes have a higher protein content than grasses. Growing animals have a high protein requirement that can be met to a large degree by adequate legumes in the forage mix. Furthermore, the palatability and digestibility may also be improved. Forage legumes fix the atmospheric nitrogen, release in the soil high-quality organic matter and facilitate soil nutrients' circulation and water retention. Based on these multiple functions, legume crops have high potential for conservation agriculture, being functional either as growing crop or as crop residue.

Examples of forage legumes are: alfalfa, *Centrosema pubescens* (Centro) *Desmodium unicinatum* (Silver leaf desmodium); *Desmodium intortum* (Green leaf desmosium) and *Lablab purpureus* (Lablab) among others.



Green leaf desmodium

Silverleaf desmodium





Siratro





Lablab



Centrosema

5.3.2.3. General guidelines on pasture establishment and management

Providing a sustainable feed-base in a goat enterprise is important to maximise productivity and to ensure farmers can meet the year-round demand for quality products. Economic growth of the goat enterprise will depend to a large extent on the establishment and maintenance of pastures. Pasture renovation is also important for weed management, irrigation and nitrogen supply in cropping systems. Before establishing a new pasture or renovating existing pasture, goat farmers must evaluate the farm's forage needs. **Pastures** are often sown as a mixture of species with the seeds being small, sensitive to the conditions and slow to **establish**.

Key steps involved in establishing a pasture

- 1. Soil testing
- 2. Seedbed preparation
- 3. Selecting pasture species adapted to the specific area
- 4. Seed quality
- 5. Pre-planting seed treatment
- 6. Seed dormancy
- 7. Seed rates
- 8. Sowing time
- 9. Sowing methods
- 10. Depth of sowing
- 11. Grass-legume intercropping for sustainability goat production
- 12. Pest and disease control
- 13. Fertilizer requirements

1. Soil testing:

In agriculture, a **soil test** commonly refers to the **analysis** of a **soil** sample to determine nutrient content, composition, and other characteristics such as the acidity or pH level (acidity or alkalinity of a solution). A soil test should be done before sowing in order to correct any mineral deficiencies. Contact your extension staff for advice on where to do the analysis.

2. Seed bed preparation

Good seed-to-soil contact is essential to maintain adequate moisture near the seeds. This moisture is necessary for germination and for the small root systems of young grass seedlings. The best type of seedbed preparation depends on the type of equipment available and whether a new pasture is being established (conventional tillage) or an existing pasture is being renovated (no-till drill). The characteristics of a good seedbed are: uniformly firm soil to depth of 5 inches (12.7 cm), adequate soil moisture, and weed free. Seedbed preparation must be done before the rains begin. A well-prepared seedbed is required to: (a) create a favourable environment in which seeds will germinate and grow. If vegetative material is being used, it is good for starting new roots and shoots; (b) destroy unwanted plants and weeds and; time the seedbed preparation aiming at striking a balance between achieving adequate soil moisture for germination and minimising the risk of high intensity rainfall. If the land has some kind of a slope, work across the slope. If the soils are shallow and likely to be highly susceptible to erosion, leave strips of undisturbed soil across the slope to reduce the potential for soil erosion.

3. Select pasture species adapted to the specific area

When establishing a pasture, it is important to match forage species to the site, soil type, and type of feeding (zero-grazing and animal species). Good pastures must have the following characteristics: tolerance to cutting, resistance to drought, high nutritive value, high palatability and, high biomass forage production. Consult your extension staff.

4. Seed quality

Poor quality seed will lead to poor and prolonged pasture establishment. Seed germination and contamination with weeds should be checked. Seeds should not be stored for too long.,

they should be planted as soon as possible to ensure a high germination rate. Good pasture seed should have a good germination percentage. Seed quality affects germination of the seed.

A simple viability test:

- Randomly take 100 seeds from the seed you intend to use.
- Put the seed on a wetted container such as a blotting paper or a perforated plastic plate.
- Make sure the seeds get enough light and water.

After 7 days, count the number of seeds that have germinated.

Percent (%) germination = Number of seeds that have germinated x 100 100

100

Good pasture seed should have a germination percentage of over 30% for grasses and over 70% for legumes. Get good quality seed from reliable sources. Consult the experts on pastures.

5. Pre-planting seed treatment

Many pasture legume seeds e.g. siratro and centro have hard seed coats which are impermeable to water. This results in poor germination and establishment. To achieve good seed establishment, rapid and even germination, some pre-planting seed treatment may be undertaken. Pre-planting treatments include: mechanical scarification or abrasion of the seed coat, hot water treatment and, inoculation of forage legume seed with appropriate rhizobia

(a) Mechanical scarification or abrasion of the seed coat:

This is the most common treatment for small quantities of pasture legume seeds such as centrosema and siratro. It involves rubbing gently small quantities of seed between two sheets of sand paper held in the palm of the hand. For larger amounts, a mechanical scarifier (e.g. a cement mixer containing some gravel) can be used.

(b) Hot water treatment:

- Boil about one litre of water.
- Put 1-2 kg of seeds into a cloth bag and dip it into boiled water (removed from boiling place) for 2 minutes. All the seeds must be submerged and in contact with the boiled water.
- Soak the seed in cold water for 12 hours.
- Dry the seeds for 1-2 hours.
- Treated seed should preferably be sown soon after immediately.

(c) Inoculation of pasture legume seed

Inoculation of pasture legumes prior to sowing is recommended when introducing new pasture legume species into new areas. Many pasture legumes are specific in their Rhizobium requirements and special inoculum is required. If the specific Rhizobium is not available, then the soil from rhizosphere of nodulating plants of the same species should be mixed with the seed. For details, consult your extension officer.

6. Seed dormancy

This is the innate inhibition of germination of a viable seed even placed in most favourable environment for germination. Storage of pasture grass seed for 3-6 months in a cool dry place overcomes this. The major reasons of seed dormancy are: immaturity of embryo; after ripening, impermeable seed coat, hard seed coat and seed inhibitors.

7. Seed rates

Seed rates depend on pasture species and seeding method. Consult your extension staff for the recommended seed rate.

8. Sowing time

Seeds planted at the beginning of the rain season have plenty of moisture for germination, but they sustain increased weed pressure. Late planting results in poor germination.

9. Sowing methods

Pasture crops can be propagated using: vegetative materials or seed.

(a) Vegetative planting:

Vegetative planting materials are often used for pasture grasses because:

- Adequate pasture grass seed of good quality (e.g. Brachiaria) is often not available.
- Grass seed is too expensive and often beyond the reach of most farmers.
- The viability of most grass seed is often too low.
- Some pasture grasses e.g. Napier grass do not produce seeds.

Vegetative materials may be in form of rhizomes, stolons, stems, splits, cuttings, potted seedlings and rhizomes. Vegetative materials can be obtained by breaking up larger clumps into pieces or using the small tussocks along the stolons that establish readily.

(a) **Sowing from seed (Why is sand needed to plant small pasture seeds?)** Tiny pasture seed such a Green leaf desmodium, Rhodes grass, Siratro and Centrosema is difficult to handle. It is easy to end up with the entire packet of seed in a pile on your field. This wastes seed, reduces germination rates and increases the time spent thinning. There are several ways to solve this problem. One of them is to **mix the seed with sand**, or other fine material.

Mixing pasture seed with sand

Mixing seed with sand spreads the seed out and makes it less likely you will drop too many seeds in any one spot. Mixing it with sand also provides some cover for the seed so it does not dry out as soon as it sprouts but does not bury it so deeply.

- Mix a packet of seed with about r times as much sand.
- Drop the seed/sand mixture sparingly along the row or area where you want to plant.
- Or, put the seed/sand mixture in a salt shaker with holes large enough for both the seed and sand to come through and sprinkle the mixture in the planting area.

There are two types of sowing methods namely: broadcasting row and spacing.

(a) **Broadcasting or sowing in swards**

The seed is spread in the field while considering the direction of the wind for even distribution. Sowing in swards or broadcasting has a disadvantage of using a higher seed rate. However, it has advantages of producing more pasture for livestock and of controlling soil erosion.



A farmer broadcasting seed in the field

(b) Row spacing

The seeds are hand drilled into furrows of about 2 cm depth. Pasture crops are planted in rows or straight lines, either singly or in multiple rows, mainly to enhance maximum yields as well as for convenience. An east-west row orientation is preferred to maximize light absorption, but this is not always possible. In many cases the topography that includes the shape, terrain and slope of the land, as well as the location of existing vegetation, roads, irrigation lines, buildings and physical barriers, dictate the row orientation. Sowing in rows has several advantages: a lower seeding rates is used; makes weeding



Seed is hand drilled into furrows

Row planted Rhodes grass crop

easy; harvesting is usually a lot easier; with climbing legumes such as Centro, Lablab and Siratro, better yields are harvested from row-spaced trellises; light exposure is maximized. Conversely, the excessive shading effect of other plants is minimized thus favouring more efficient photosynthesis and improved crop yield; access through the inter-rows facilitates cultivation, weeding, and other farm operations including hauling; movement within the crop area is more convenient and allows close inspection of individual plants and visibility is enhanced.

Planted seed must be lightly covered with soil using a rake or a leafless branch to ensure good seed and soil contact and for protection from birds and being washed away by rain. Mixing it with sand provides some cover for the seed so it does not dry out as soon as it sprouts but does not bury it so deeply it dies before it emerges from its blanket of soil. The seeds germinate in about 7 days.

10. Depth of sowing

One of the commonest causes of failure in establishment of small-seeded species is sowing too deeply. Thus, the timing, rate and depth of sowing are critical. Since most pasture plant seeds are relatively small, they are generally sown on the surface of the soil or incorporated to not more than 1 cm depth.

11. Grass-legume intercropping for sustainability goat production

Seasonal and low forage availability and quality, shrinking of grassland area, and poor grassland management are the main causes of low soil fertility and goat production in Uganda. One sustainable way to overcome the problems is through establishment of grass-legume intercropping in pasture grasses. Pasture grass-forage legume intercropping improves soil health and fertility, forage yield, and stability and reduced weed invasion. Besides, it improves forage nutritive value and goat production. To enhance pasture grass-forage legume intercropping, the selected grass and legume species should be matched with local environmental conditions followed by good management.

12. Pest and disease control

Planted pastures should be monitored closely for any sign of insect attack, disease and germinating weeds. Corrective measures should be applied as soon as possible.

Pasture management

If goat farmers could match the feed requirements of a goat to the amount of forage growing in a field for a given period of time it would provide them with a significant number of benefits. To accomplish this, you need to focus on fields and the forages growing in them. Think of your pasture as your crop and your goat as means to harvest and add value to that crop. A wellmanaged grass pasture is one of the most cost-effective and high value feeds that can be produced and utilized. Pasture management can provide significant benefits including improved forage yields, lower feed costs and improve livestock performance. Benefits from well managed pastures:

- maximized forage production = lower feed bills;
- better livestock health = lower veterinary bills;
- minimizes risk of contaminated runoff from livestock manure and degraded pastures polluting local waterways and;
- healthy pastures look better than muddy, weed ridden fields.

Important factors to consider for successful management of pastures include:

- (a) Fencing
- (b) Weed control,
- (c) Fertilizer requirements,
- (d) Pest and disease control,
- (e) Irrigation and,
- (f) Cutting/harvesting management
- (g) Rotational grazing

(a) Fencing

Fencing is the most critical factor in raising goats on pasture. There is nothing more frustrating than having to constantly chase goats back into the pasture. Fencing will also be the greatest expense, other than the initial cost of the animals. The best permanent fencing is 4-foot woven wire with barbed wire along the top. Some graziers are also successfully using four or five strands of high-tensile electric wire. Goats may have to be trained to electric fences by placing them in a small paddock to "test" the wire. Once they have been trained to an electric fence, goats can usually be controlled with two strands of wire in a cross-fence. Electric netting is
also an option for temporary or permanent fencing in management intensive grazing systems; however, several goat producers have lost animals that tangled their horns in the netting.

(b) Shelter

Goats also need shelter. They can tolerate cold weather, but goats will get chilled by wet, cold conditions. The necessary shelter or shelters depend on the producer's operation. A dairy operation will usually have extensive barn and pen set-ups, while a large meat goat operation may use only trees in the pasture as shelter. Buildings used for shelter may be minimal, but they should be well-ventilated and clean. Barns and sheds are not the only options for shelter. There are portable shelters, moveable shades, and even old hog huts that can be used as shelters for your animals. Predators are a problem in most areas where goats are produced.

(c) Weed control

A weed management plan will help ensure success in forage establishment. It is important to control weeds during establishment because newly emerged forage seedlings are extremely susceptible to weed competition. Weeds compete for water, nutrients, and sunlight. Broadleaf weed control is possible but may require multiple applications or applications at different times of the year. Applications at different times during the year will better control weeds that germinate during different seasons. Because new herbicides are constantly being developed and formulations of existing herbicides frequently change, consult with your area extension for more information.

(d) Fertilizer requirements

Adequate soil nutrients are required to promote plant growth, tillering, branching and subsequent seed production.

Pasture grasses

Nitrogen is the main nutritional determinant of pasture grasses and split applications after one month of sowing and at flowering, each of 50-100 kg/ha Nitrogen, are commonly used based on the fertility of the soil. This implies that after application of the two split doses, the total application rate of Nitrogen will range between 100-200 kg/ha. Single dose application of Nitrogen is discouraged as the plant will not have adequately developed to effectively utilize all the applied nitrogen. As such, much of the Nitrogen is often wasted and is not channelled into vegetative and seed production. At times, the grass benefits from application of phosphate fertilizers at sowing if phosphorus is limiting. However, a farmer is advised to consult a local extension staff or a soil scientist before such a decision is taken.

Pasture legumes

Nitrogen is often not limiting in pasture legumes because the Nitrogen fixing bacteria found in the root nodules of legumes have the capacity to utilize atmospheric Nitrogen and fix it into soil. The fixed Nitrogen is then utilized by the leguminous plants. Ensuring adequate availability of phosphorus is crucial if adequate fodder yields are to be realized. It should be noted that the rate of application will depend on the phosphorus content and pH condition of the soils. When the soils are strongly acidic, application of phosphorus is merely a waste as most of it is simply fixed and rendered unavailable for plant uptake. Under such conditions, amendment of the soil with lime shall improve the soil pH conditions and hence prevent fixation of applied phosphorus.

(e) Pests and disease control

They can have a significant effect on the establishment, yield and longevity of grass and forage legume crops. In grassland, new reseeds are most vulnerable to attack and problems are more likely to occur where grass is the main crop in the area and particularly when grass follows grass. Integrated pest management (IPM) such as the use of "Push and Pull" technology in the control of maize stem borers involves using a combination of biological,

cultural and chemical control methods to control pests. As beneficial insects are a key component of IPM, the use of insecticides is minimised, but not excluded altogether.

Disease and deficiencies pose a similar risk as pests and should be monitored when checking pastures for pests. Diseases can generally be classified as leaf eg rusts, or root diseases eg wilt or root rot. Management for disease control should be proactive and reactive. Proactive control begins prior to pasture establishment and takes into consideration paddock and disease history as well as pasture species selection for disease resistance. Reactive disease control involves managing outbreaks and may include strategic grazing and chemical application. In extreme cases, cultivation and cropping may be required to break a disease cycle.

(f) Irrigation

Pastures often become unproductive or go dormant in dry seasons due to lack of water. Forages respond to irrigation at any vegetative stage. The yield increase is linear to the total water applied up to the amount needed by the plant for daily growth. The critical question is whether the extra pasture forage that may be produced on average will be worth the cost. A farmer should thoroughly consider all the issues that contribute to irrigation system cost.

(g) Forage harvest/cutting management

It is important to note that for most grasses and legumes, forage yield increases as cutting frequency decreases while forage quality declines. The digestibility of both grasses and legumes decreases with maturity, implying that forage should be fed at a younger stage for maximum energy digestibility. A wide range of digestibility occurs both between and within pasture species. One has to compromise between maximizing forage yield and quality and try to improve the latter by using better species for milk production.

In general, defoliation through cutting or grazing affects both above ground growth and the underground rooting system. In the case of forage legumes, it affects also nodulation and nitrogenous activity. When sufficient fertilizer and moisture are available, a 6 to 10 weeks regrowth interval should be the practice to obtain optimal yield and quality of forage, except in the dry season, when the cutting interval may inevitably be prolonged.

Delayed harvest usually allows more carbohydrate and nitrogen storage in roots of uprightgrowing legumes or in the lower plant parts of grasses, which can be used to support regrowth vigour and persistence. Vigorous plants are more competitive with weeds and other species resulting in better plant persistence, especially the proportion of desirable legume plants within mixed swards. Depending on livestock requirements, or for non-livestock purposes, harvest management requires compromises to produce the largest quantity of a quality product for the desired number of years.

Allow plants to become well established before heavy grazing or set stocking. Cut the pastures when plants are 8 to 12 inches tall. Most forage crops should not be cut shorter than 3 to 4 inches. Maintaining proper cutting height will help trigger new plants to tiller or producer runners. Allow plants to grow to 8 to 12 inches before cutting again.

(h) Controlled grazing

In many parts of Uganda continuous grazing is a common practice, characterized by giving the animals unrestricted access to the pasture throughout the season. This works well for goats. However, feeding goats in a sustainable and economical way is better accomplished by a controlled, rotational grazing system. Fresh, clean water must always be available. Along with water, minerals need to be available to your animals at all times. It is best to feed calcium, phosphorous, and trace minerals in a salt mixture to ensure that the animals actually eat them. In some operations—particularly dairies—goats are raised in confinement, and all their feed is brought to them. However, allowing goats to graze can lower costs by:.

- reducing purchased grain costs
- eliminating forage harvesting costs
- eliminating manure removal costs
- · lowering fertilizer costs as manure nutrients are returned to the soil

5.4. Fodder trees and shrubs

Fodder trees and shrubs have high levels of protein. Fodder plants provide the nutritional needs of goats. Examples of fodder trees are *Gliricidia sepium* (Gliricidia), *Leucaena leucocephala* (Leucaena), *Sesbania sesban* (Sesbania) and *Calliandra calothyrsus* (Calliandra). Fodder shrubs include *Tithonia diversifolia* (Mexican Sunflower) and *Cajanus cajana* (Pigeon peas)



Calliandra

Gliricidia



Pigeon peas

Sesbania

Leaves of fodder trees and shrubs can be harvested, dried, milled and incorporated into feed rations such as dairy meal, nutrient feed blocks and dairy and pellets for home use or for sale. Fodder tree banks do not provide 100 percent of feed requirements but supplement available low-quality pasture and crop residues with high quality protein.



Mexican sunflower leaf hay



Calliandra leaf meal

Nutrient feed blocks

5.5. Indigenous fodder trees and shrubs

Indigenous fodder trees and shrubs (IFTS) play an important role in bridging the gap in fodder supply during the critical dry months in Uganda. Being perennials, indigenous fodder trees and shrubs are able to withstand prolonged periods of moisture stress than grasses and herbaceous forage legumes such as Lablab. In many parts of Uganda, indigenous fodder trees and shrubs are the only source of green forage available during the dry season. In addition, many fodder trees and shrubs have high nutrient value that supplement the often-poor quality grasses and crop residues, the normal dry season feeds. The protein content of most IFTS is higher than 15%, compared to that of grasses (less than 12%). Below are examples of indigenous fodder trees and shrubs.

Scientific name	Common name	Part used as fodder	Propagation
Persea Americana	Avocado pear	Leaves and seeds	Seed and commercially propagated by cleft or grafting or budding
Moringa oleifera	Horse-raddish tree	Leaves	Direct seedlings, seed and cuttings
Cajanus cajana	Pigeon peas	Leaves, twigs and seed	Seed
Psidium guajava	Guava	Leaves and fruits	Seed, wildings
Morus alba	Mulberry	Leaves and fruits	Seed and cuttings
Ficus natalensis	Fig tree, Back-cloth	Leaves	Cuttings and seedlings
Alibizia coriaria	Albizia	Leaves	Seed, wildings
Acacia spp.	Acacia	Leaves and pods	Seed, direct sowing, wildings
Tithonia diversifolia	Mexican sunflower	Leaves and young shoots	Direct seedlings, seed and cuttings
Vernonia amygdalina	Bitter leaf tree	Leaves and young shoots	Seed
Manihot spp	Cassava	Leaves and young shoots	Cuttings and seed
Sesbania sesban	Sesbania, Riverbean	Leaves	Seed
Artocarpus heterophyllus	Jackfruit	Leaves, twigs and seeds	Seed
Mimusops bagshawei	Mimusops, Red	Leaves	Seed

Table 3: Examples of indigenous fodder trees and shrubs fed to goats



Mimusops bagshawei



Back-cloth fig tree



Bitter leaf tree



Jackfruit leaves



Avocado pear



Mexican sunflower

5.6. Crop residues

Crop residue is the portion of planted crops left over after harvesting human food crops or after processing of the main product. The quality of crop residues is generally poor since they are high in fibre and low in digestibility and crude protein. However, they form a big proportion of dry season feed for goats in smallholder farms in Uganda. Major crop residues fed to goats include sweet potato vines, maize stover, cassava peels and leaves, banana peels, banana leaves, pineapple and bean residues etc.



Banana peels

Sweet potato vines



Bean residues

Pineapple residues





Maize stover

Banana flower

Most crop residues are low in protein and high in fibre content, which leads to their poor utilization by livestock. Crop residues must therefore be supplemented with a source of protein such as lablab. Intercropping cereal crops such as maize with forage legumes improves the quality of maize stover and maize grain yield.

Factors affecting crop residue quality

(a) Stage of crop at harvest

When a crop is harvested early—for instance, green maize harvested for roasting the resultant residue is of higher quality compared to stover, which is obtained after maize is harvested after drying in the field.

(b) Harvesting method

Harvesting of stover should minimize the loss of leaves as they are more nutritious than stems. It is preferable to harvest crop residues in the morning when leaf shattering is low because of the presence of morning dew. The quality of crop residue is reduced when some of the plant parts are lost through shattering or breakage.

When crop residues are left in the field they are exposed to sun and rain, the nutrients are washed away, and they may decompose or be attacked by ants. Hence, the quality goes down. When stored for too long, the feed resource dries too much, loses colour and may decompose.

5.7. Agro-industrial by products

Agro-industrial by-products are mostly derived from agricultural processing industries such as cereal grain milling, oilseed extraction, cereal milling by-products (maize and rice bran) molasses, brewery, malt production, fruit and vegetable processing. These represent a vast potential source of energy and protein to the goats.

The major problems facing the use of agro-industrial by-products for animal feeding are their bulkiness and availability; high cost of transport; the general lack of understanding among goat owners about the feeding value and the relatively poor nutritive value of most agro-industrial by-products







Molasses

5.8. Conserved fodder

Forages and crop residues can be conserved to feed dairy cattle during periods of feed shortage caused by limited pasture growth or inadequate pasture conditions or fed as a supplement. Conserved forages can take the form of **hay**, **haylage** and **silage**. It is important, to keep this fact in mind "*At best, conserved forages can rarely match the nutritive value of fresh forage because some losses of highly digestible nutrients (sugar, protein, and fat) are unavoidable during conservation and storage"*. The goal in forage conservation is to focus on minimizing losses, which start immediately after cutting.

When selecting a conservation method, a farmer should consider the following:

- suitability of the forage for a given method,
- storage capability,
- weather conditions,
- the intended use of the conserved forage and,
- the selected conservation technique should maximize nutrient conservation efficiency and minimize production costs.

1. Hay production

Hay is "grass, legumes, or other herbaceous plants that have been cut, dried, and stored for use as animal fodder".

Steps in hay production

(a) Visual assessment

Grass for hay production is cut when about 10% of the crop is flowering. At this stage, the plant is full of energy, protein and sugars. Plants must have a high leaf-to-stem ratio. The more leaves the better because they are packed with nutrients.

(b) Mowing

Use sharp blades, like sickle or a hand shear to cut the plants at least 1 cm above the ground. Cutting too low will affect the plant's ability to regenerate.

(c) Drying

Leave the harvested material in the field to dry for 2 to 3 days depending on the forage species. Hay production must therefore be done during the dry season to allow the forage to dry properly. Drying stops the plants' chemical and biological activity and reduces the possibility of the hay going mouldy. The harvested forage can be hung in a well-ventilated moisture free structure to ensure quick drying in the absence of sufficient sunshine.

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(d) Raking

The dry grass is raked into heaps. This helps stop the dry grass from blowing around the field and means it is all lined up and ready for baling.

(e) Baling

Care must be taken to ensure the leaves and stems remain intact and that the moisture in the hay is just right. If the bale has not dried out enough, it will turn into a hot compost heap that could start a fire. Baling can be done using a wooden bottomless hay baler for small quantities of hay; or tractor mounted with a baler.

Manual box baling has practical application whenever resource-poor people transport, store and stall-feed bulky dry forages (grass and legume hays, fibrous crop residues such as maize and sorghum stover; cereal straws (millet, cereal straws of rice, wheat, barley and oats), and bean haulms. The measurements for the wooden bottomless box are: 75 x 50 x 40 cm.



Wooden bottomless box

Baling hay using a wooden baling box

- (a) Lay four sisal strings of about 10ft long at the bottom of the box with two strings across each facing side of the box meant for tying up the packed material.
- (b) The dried fodder is placed in the hay bailing box. When the box is full, the fodder is thoroughly compacted until when no more dry fodder can be added into the box.
- (c) Remove the bales from the baling box.
- (d) Transfer the bales into a hay barn where it's kept until it's utilized for livestock feeding



The hay is compacted in a hay baling box

Tying hay

The barn must be well ventilated to aid in further drying of the bales as well as to prevent accumulation of moisture that could lead to mould development on hay. The floor of the barn should consist of a raised perforated surface to allow air circulation under the bales.



Removing hay from the baling box

A simple hay rack

Characteristics of good-quality hay

Good-quality hay should have the following characteristics:

- leafy and greenish in colour,
- has no foreign material mixed with it and,
- has no smell.

How do you feed grass hay to dairy cow?

- (a) Chop grass hay on a canvas or tarpaulin.
- (b) Mix chopped grass hay with 30 percent leguminous forages such as Gliricidia or Calliandra leaf hay to improve the protein content of the feed.
- (c) Mix molasses and water in a ratio 1:3 (molasses: water).
- (d) Sprinkle diluted molasses on chopped grass hay to improve the energy content, palatability and acceptability by the animals. Salty water can also be sprinkled in the absence of molasses.
- (e) Supplement the hay with a source of energy such as dairy meal or dairy pellets depending on their availability.
- (f) Intake of grass hay depends on the liveweight of the cow, quality of hay and whether or not grass hay is the only constituent in the diet. As a guideline, excluding wastage, the daily requirement of hay is 3 percent of the animal's body weight with at least 30% of the total intake being legume hay.

2. Silage production

Silage is the green succulent roughage preserved more or less in its original condition, with a minimum deterioration and minimum loss in respect of various nutritive constituents of fodder. Silage can be made from maize, Napier grass fodder, sweet potato vines, pineapple residues and other crop residues. This is nutritious silage consisting of fresh sweet potato vines preserved in airtight container.

Types of silo

There are many types of silo: polythene tube, trench, bunker and above-ground. Which you choose will depend on how much fodder you have and how much the silo will cost. This leaflet focuses on the polythene tube silo, which is most appropriate for small-scale farmers who are making silage for the first time.

Polythene tube silo for small-scale farmers

A polythene tube is good when making silage from less than 3 tonnes of fodder. A 2.5-metre polythene tube can hold up to 500 kg of fodder. Trench, bunker and above-ground silos are good if you have more than 3 tonnes of fodder.

When to cut the fodder

• Maize fodder is best at dough stage, when green maize is at roasting stage.

- Sorghum fodder is best at dough stage.
- Napier is best when cut at 1 metre height.

To make 100 kgs of silage you require:

- 90 kgs fresh vines
- 10 kgs of maize bran
- If unmarketable roots are available, mix 75 kgs vines with 15 kgs roots
- 1.5 metres of polythene tubing (600-800 gauge).
- 2 metres of sisal twine (divide this into two).
- Labour: one person.

1. Making a silo

The container in which the silage is kept is called a silo. A simple plastic tube container (tube silo) made in such a way that it can be closed off to exclude air is suited for smallholder farm conditions. A 200 kg plastic drum can also be used as a silo.

- First open up the polythene tubing.
- On one open end of the tube make pleats 20 cm long starting from the end towards the centre on each side of the tubing.
- Twist the pleats together and tie off with the string.
- Turn the tubing inside out so that the tied knot is on the inside.



Tie one end of a tube



Turn the tube inside out

- Chop the fodder to be ensiled into pieces of about 2-2.5 cm length using a panga or a chopper.
- Spread out the chopped material and let it wilt for 4-6 hours.



Chopping fodder

Wilting chopped fodder

• Place a plastic tube into another 100 kg synthetic sac (used for packing sugar, salt, rice and maize flour). The synthetic sac protects the polythene tube from being damaged by rodents and hot weather.



Place the polythene tube silo into a- 100 kg synthetic sac

- Weigh the fodder
- Uniformly sprinkle 10 kgs of maize bran (ferment starter) for every 100 kgs of chopped residues OR dilute molasses solution at a ratio of 1 part molasses with 3 parts water.
- Spread maize bran or diluted molasses over the chopped residues and mix thoroughly. Molasses provides sugar (energy) to animals, improves palatability of feed rations and aids fermentation during silage making. Molasses or maize bran increase the production of lactic acid which serves as a preservative.



- Fold the top half of the tubing over the sides of the lower part. Fill the tubing a little at a time with chopped mixed material. Every after adding about 25 kgs step over the material to compact before adding more. Take care not to tear the polythene tube. Fill until about one quarter of a meter is left.
- Use a sisal twine to tie off the top firmly excluding the air in order to encourage the growth of fermentation bacteria



• You can use plastic drums or reusable plastic silo bags.



Plastic drums

Reusable plastic tube silos

• Store silage bags silos under a shade. Concrete or a wooden floor provides excellent surface for silage bags, easy removal of feed with little or no damage, can achieve exceptional drainage of water away from bags, discourages pests and makes inspection for damaged bags very easy. Rodents like rats that could tear the tube need to be controlled. Under anaerobic conditions, silage can be stored for up to 3 years.





Maintenance of silage bags

- Number and date each bag for easy identification and recall of materials bagged.
- Do not allow dogs, cats, children and other animals to climb the bags.
- Inspect the silage bags on a regular basis and if possible and seal holes at once. If damage is extensive, the silage needs to be re-bagged as soon as possible.
- Do not leave the silage bags opened overnight.
- If maintenance is appropriate after 21-30 days, excellent lactic acid fermentation will result and bags kept well for six months, with no or little fungal spoilage.
- After emptying, the bags must be carefully washed, dried and stored in a safe place for use the following year.

Characteristics of good quality silage

- Well-preserved silage is green, yellow, or pale brown. Dark brown silage is poorly preserved.
- Well preserved silage has a sweet, tobacco smell. Foul, rancid smells indicates poor preservation.
- The silage is liked by animals because of good taste and pleasant aroma.
- No mould growth.
- Good silage is free flowing and non-sticky texture.
- Good silage has a protein content of about 18 percent.



Maize silage

Recommendations on feeding silage to goats: Key messages

- Farmers rearing goats can reduce the cost of production by over 50% through adopting sweet potato vine silage technology.
- A goat should be supplemented with 1-2kgs depending on it weight.
- Remove enough silage to feed your goats for the whole day and tie the silage bag again to ensure air or water does not get in.

- Farmers should note that this does not completely replace commercial feeds, it only enhances the goat growth rate hence one sells his goats faster as it is taken to be a snack.
- Water should always be available for the animals otherwise they will not be able to feed properly hence growth rate will be affected.
- Control diseases and pests.

Utilization of haylage

When dry grasses and legumes generally are ensiled the term 'haylage' is used.



Maize stover haylage

The dry straws are improved by addition of suitable additives namely molasses; urea; mineral mixture and water.

- Chop the straws or stover into fine pieces (2-3cm).
- Add 1 kg of urea and 1.5 kg of mineral to 20kg of water.
- Mix with 97.5 kg of the chopped material.
- Store in silo bags like silage and allow to ferment under anaerobic conditions. The soluble carbohydrates present in the dry straws act as a source of energy for the bacteria to grow well.
- After about 30 days the pits, open feed to livestock.
- Supplement with 2kg of green fodder per day per animal to take care of the requirement of vitamin A.

5.9. Hydroponic green fodder

Inclusion of green fodder in a goat diet improves productivity and increases profit. Green fodder provides proteins, carbohydrates, minerals, vitamins and a source of water (about 15 to 25 percent water). Therefore, for economical and sustainable livestock farming, green fodder production round the year is highly essential.

Hydroponics green fodder is the livestock feed produced using hydroponics technology, "a method of growing plants without soil".



Hydroponics green fodder

Hydroponics farming is a solution to all animal feed challenges. Hydroponic fodder unlocks the energy potential of grains. It can be fed to all livestock; cattle (dairy and beef), goats, sheep, rabbits, pigs and chicken. Other grains that can be used include: barley, oats, wheat, sorghum, millet, maize. The fodder is highly nutritious with 23-30 % crude protein. Inclusion of hydroponic maize fodder in goat nutrition improves performance and nutrient digestibility of weaned goats. Sole feeding of hydroponic maize fodder exerts negative effects on the performance of livestock.

Why grow hydroponics green fodder?

One of the best reasons for sprouting grains into fodder is that it helps stretch your animal feed budget. Fifty (50kgs) of whole grain can be transformed into as much as 300 kgs of fodder simply by sprouting it. Sprouting grains increase their nutritional content and boosts protein content slightly. And while it is great for goat feed, this fodder works as feed for other livestock as well.

How to grow fodder for goats

Sprouting grains into fodder requires a little bit of set up, but it's not difficult. You'll need a tray to get started. The essential thing is that you are able to drill drainage holes in the trays.

Requirements:

- Shallow trays you can use plastic trays,
- Shelving or a rack on which to place the trays,
- Drill with a one-eighth-inch bit,
- Bulk whole grain barley, wheat, maize, or oats work well,
- Bucket and,
- Water

Making the hydroponic fodder system

• Drill several drainage holes in the bottom each tray. Test to make sure water drains sufficiently.



Metallic tray with holes

soaked seed on a perforated plastic tray

Where to put your growing fodder trays

The fodder system can be set up outside near the goat house, making it easy to access and maintain.

Growing fodder

- Soak grain in a bucket of water overnight. Cover the grains by about two inches of water. How much grain to soak depends on the size of your trays and how many you are filling. Aim for a half-inch depth for each tray. The grains have a tendency to mould if they are deeper than that.
- Drain grains and transfer to trays. Spread evenly.
- Water each tray morning, midday and evening.
- In case of maize, germination starts on the 2nd day and the roots are clearly visible from 3rd day onwards.
- You will see roots within the first couple of days, followed by greens. It takes 8-10 days to have a nice solid block of fodder that you can lift out of each tray.
- Harvest on **Day 8**. One tray containing 1.0 kg maize seeds can produce 5 to 8 kg green fodder with fodder height of 20 to 25cm.
- Average protein content of hydroponic green maize fodder is 13 percent. Hydroponic green fodder looks like a mat consisting of roots, seeds and plants.



Goats feeding on hydroponic green fodder

5.10. Minerals

Goats need mineral supplements for good bones and teeth, appetite and weight gain and improve the hair coat appearance. Feeds provide some of mineral requirements but extra minerals in the form of commercial mineral mixtures should be provided the whole year round.



Commercial mineral block

Required mineral nutrients are mainly provided from commercial mineral mixtures. Phosphorous is very necessary for reproduction. Rock salt, though deficient in most of the essential mineral nutrients, should be provided in the goat house.

5.11. Concentrates

Whether they are kept for milk or meat production, goats deserve special attention. Energy has been identified as the most limiting nutrient for milk production in dairy goats. Concentrate feeds are valued for their energy and protein levels and their protein quality, which result in improved goat productivity. Concentrates or grain should be fed to goats with higher energy requirements. This includes goats that are still growing (i.e. weanlings), pregnant, or lactating.

- Feed a concentrate formulated for goats to ensure that it is adequately balanced to meet their specific needs.
- Feed concentrate once or twice per day. Smaller, more frequent meals help maintain rumen health and prevent ruminal acidosis, a potentially deadly condition.
- Separate goats based on production stage (i.e. pregnant, lactating, or growing) to allow time to consume an increased volume of feed without competition.
- A good place to start is 0.25-0.5 kgms of grain per goat/ day of a 14-16% protein goat concentrate. Utilize stage of production and body condition scoring to further tailor the amount of grain for individuals.
- Small quantities (0.5-2 kg/goat/day) of concentrates can lead to an increase in the intake of low quality forages which in turn increases milk yield of dairy goats.
- Dry does, castrated goats, and non-breeding bucks can have a small handful of grain as a treat, but do not need concentrates to meet their nutritional needs. Excessive grain consumption can put castrated goats at an increased risk of urinary stones and should be avoided.
- A small quantity should be fed to the goat before kidding in order to build up the body reserves and help in the development of the unborn kids.
- If concentrates are fed, free-choice baking soda should be made available. Concentrates can make the rumen more acidic leading to problems such as laminitis and liver abscesses. Baking soda will help offset ruminal acidosis by providing a buffer.

Tables 2 and 3 show examples of concentrate mixtures for dairy goats.

Table 2: Suggested dairy meal rations to be fed daily

Туре	Quantity per day
Dry female	0.5 kg
Female milking 1 litre	1.0 kg
Female milking 2 litres	1.5 kg
Female milking 3 litres	2.0 kg
Female milking 4 litres	2.5 kg
Female milking 5 litres	3.0

Table 3: Examples of a concentrate mixtures for dairy goats

Ingredient	Concentrate mixture 1 Qu	Concentrate mixture 2 Jantity (kgs)
Maize bran	7	7.5
Soyabean meal	0	1.5
Meat bone meal	1.5	0
Cotton seed cake	1.5	5.0
Salt	0	3.0

5.12. Water

Goats need access to fresh, clean water at all times. The amount of water needed by a goat varies with the breed, climate, the type of feed eaten and the purpose for which the goat needs water e.g. for milk and growth.

Normal recommendation: Goats consume 4 times as much water as Dry Matter but for lactating goats, provide 1.3 litres of water per litre of milk produced. Provide clean water all the time.

5.13. The best way to feed goats

- Feed only clean, fresh and dry fodder
- Clean the feeding trough and water bucket every day
- Give lots of different feeds such as grasses and legumes, tree leaves and fresh kitchen remains.
- Give chopped mixed feeds to make sure the goats eat everything and does not waste Feed.
- Feed goats at least 3 times a day and at the same time every day
- Put some feed in the feed trough or rack or hang up some feed to be eaten overnight
- If you use molasses to make feed taste better do not use too much it will make feed sticky
- Dusty feeds and concentrates should be wetted a little.
- Provide a Mineral Lick [block] always to all goats.
- Do not feed too much leguminous feed such as desmodium
- Mix feeds with grass, hay, straw or Napier to balance
- Only 1/3 of the day's feed can be legumes. Do not feed too much leguminous fodder. It can poison the goats
- Give more feed two months before the buck has to serve the does this will improve the bucks sperm and make it more active
- When a buck is being used a lot to serve does, it should be separated from other goats for about 2-3 hours per day. This will allow it time to eat as well as serve the does
- · Lots of fresh and clean water needed all the time
- Must be able to lick the mineral lick at any time

SECTION 6: GOAT BREEDING

The male goat is called a "buck" or "billy." If he is castrated, he is called a "wether." Male goats up to 12 months of age are sometimes referred to as "bucklings." Adult male goats can weigh between 45 to 150 kgm depending on their breed, health and nutritional status. Although they can come into puberty and breed does as early at 4 months of age, waiting until a buck is a year of age to start using him for breeding is best. The number of does a buck can breed during the breeding season is often referred to as "Buck Power".

At one year of age, the buck should service no more than 10 does at a time (in one month). When he is 2 years old, he should be able to service 25 does at a time. At the age of 3 and older, he can breed up to 40 does at one time, as long as his health and nutritional needs are met. The number of does a buck can service at one time also depends on individual sex drive of the buck, the terrain of the land and if he is managed by a hand- or pasture- mating system. The buck has the greatest genetic impact on the herd and should be well taken care of at all times.

6.1. Desired characteristics of male goats

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

(a) The dairy buck

- excellent health and sexually virile,
- a masculine body with medium-length head,
- a strong, broad muzzle with large open nostrils,
- bright eyes with pink mucosa,
- a strong, straight, smooth back,
- a long, wide and nearly level rump,
- strong, sturdy legs that are wide apart and squarely set,
- solid feet/hooves,
- a pear shaped scrotum with 2 testicles of equal size and,
- a deep heart girth and wide chest floor.

(b) The meat buck

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

6.2. Time of mating

Females should have at least 2 hard teeth at 10 months of age. Females mated when they are still young with a low body weight will produce kids will poor growth and the kid will be of little value. It is important that females are mated when there is plenty of good quality grass and leguminous forages. Mating during the rainy season will also ensure that the goats are in good body condition. If females are in good condition, they will readily come into heat and repeat services will not happen. Thus mating period of 45 days should be sufficient.

6.3. Signs of heat

When on heat, the females become restless, bleat frequently and wag their tails. The vulva is swollen and discharges a clear mucus. Females on heat will also mount other females. The duration of a cycle is from 19-24 days.

6.4. Care of a pregnant doe

As pregnancy progresses, the nutritional requirements of the female goat increases. It is important to get a cheap source but high quality feed. On average a goat will kid 150 days (5 months) after she has been mated. Females carrying twins will kid a few days earlier. It is wise to be ready for kidding 145 days after the introduction of the buck in the breeding stock.

6.5. Signs of kidding

The udder will become firm and the teats will enlarge. The female will become restless on the day of kidding, often pawing on the ground. She will have a discharge from the vulva.

6.6. Care of the doe

The female should be left alone and not disturbed during labour time. If a female has not kidded within 3 hours after the start of labour, professional help should be sought. The placenta or afterbirth will normally be expelled within a few hours after birth. If this does not happen, do not attempt to remove it because it can result in excessive breeding.

6.7. Rearing a new-born kid

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

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

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

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

From the second week onwards a small portion of concentrates and some roughage should be offered. A special concentrate is preferable, but any good concentrate will do, provided that it does not contain urea or cottonseed cake. At the beginning, the concentrate can be given in

the same bucket as the milk. Once the kid starts eating it readily, it should be given in a special feed trough.

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

Although very detailed feeding schedules exist, an effective and simple system is to give the kid some 0.2 litres of milk four times a day from the second week onwards, gradually reducing it to two times a day with an increased amount of concentrates, up to 0.2 kg a day. If the kids consume an adequate amount of concentrates, then a minimum of 25 litres of milk will suffice in the first six weeks. If concentrates are not available, more milk per day must be given for a longer period. At weaning, kids of improved breeds (50 kg mature weight or more) should weigh at least 7 kg and consume 0.2 g of concentrates per day.

After weaning: the kid still needs good quality roughage and concentrates to continue its development. Often concentrates are considered too expensive for kids, but remember that the nutritive value of 1 kg of good quality concentrates is equal to that of 3 to 4 kg milk. The period after weaning is often the most difficult, especially if high quality feed is not available or is considered too expensive. Kid mortality is highest during the first 3 to 4 months.

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

Suckling: Many local and crossbred goats will not let-down their milk without their kid being present. This does not necessarily mean that the kid has to suckle first; often its close presence will do. If this is the case the goat will stop producing if her kid dies. Therefore try milking the goat without the kid. Some farmers allow the kid to suckle the last milk for 5 to 8 minutes. This may help to reduce mastitis, but as the last milk contains the most fat, the kid may get too much fat. It is better to leave (part of) one teat for the kid, but not always the same teat. In some areas goats are milked in the morning for home consumption or sale and thereafter the kid(s) join its dam and are allowed to suckle till midday or early evening. From then on until the next morning milking, kid(s) and dam remain separated.

Points to bear in mind when rearing kids

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

Young stock rearing: The age of weaning is a point of discussion. With dairy goats one wants to have as much milk as possible for home consumption or sale, but the kid(s) also need milk. For meat goats milk is not a problem, the kid(s) can suckle all they need, there is no competition. When good quality concentrates and roughage are available dairy kid(s) can be weaned at about 6 weeks, or be fed artificial milk based on powder. Depending on the production orientation the farmer has to make a choice, but it always costs money, either through less income or by buying good concentrates. If goat milk fetches a much higher price, kids can be reared with cow milk.

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

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

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

Artificial Insemination (AI)

Buck's semen can be successfully collected, frozen, and stored. There are hands-on courses available to teach AI skills so the goat owner can perform it themselves. Achieving good conception rates with AI may be difficult because of inaccurate timing of insemination and incorrect placement of semen. However, Artificial Insemination does offer some benefits.

- You do not need to own a buck.
- Al may increase the rate of genetic improvement.
- You have a greater variety of bucks to breed to.
- It reduces the possibility of transmitting a disease or parasite to your doe.
- You can carefully regulate the time of breeding and kidding.
- It promotes good record keeping of dates, heat, breeding, pedigrees, etc

Breeding problems

There can be various reasons as to why a doe may not conceive once it has been serviced:

- Doe was bred at the wrong time
- Infertile buck or doe
- Ovary problems
- Infection in the uterus or cervix
- Health problems other than reproductive
- Nutritional problems in does

Castration of male kids

It is the removal or destruction of the testes, epididymis and a portion of each spermatic cord from a buck. Castration should ideally be done at less than three weeks of age. The importance of castrating male kids:

• To maintain and control the breeding programme

- To successfully carry out breed improvement
- To improve on farm safety for animals and handlers because castrated buck is usually less aggressive and easier to manage.
- To lessen goat smell: meat from castrated male has less smell than tainted odour in the meat from intact bucks.
- For improvement of carcass composition and weight development.

Note: It is important to let an experienced animal health practitioner show you how to do the castrations correctly before you do it yourself.

SECTION 7: DAIRY GOAT PRODUCTION

7.1. Dairy goat farming in Uganda

Dairy goat production is an alternative livestock enterprise suitable for many farmers. The potential also exists for selling milk to processors to produce specialty cheeses, yogurt. Although fluid milk and processed products are important markets, dairy goat farmers should also consider the potential for selling animals to youth involved in vocational agriculture dairy projects.



Dairy goats

According to the Dairy Development Authority (DDA), the dairy sector has over time, experienced a rapid growth from 1.5 billion litres in 2008 to 2.81 billion litres in 2020 earning the country foreign exchange valued at \$139.5 million in 2019. This is attributed to the dairy cattle with the contribution of the goat industry to the overall dairy industry unknown and not quantified. However, dairy goat farming in the country has been under developed and non-regulated overtime yet it has an enormous potential for improved health wellbeing.

7.2. Importance of goat milk in human nutrition

- Goat milk provides many nutritional and health benefits that cows' milk may not.
- Goat milk is more nutritious and has medicinal value over that of the cow.
- It has smaller fat globules size which is more digestible compared to cow milk.
- Studies have shown that goat milk can help reduce cholesterol in the arteries and gall bladder. This can help people with high cholesterol control their cholesterol more efficiently.
- While goats are much smaller than cows, a good dairy goat can provide around 3 littres of milk per day while they're lactating.
- Goat milk proteins are more digestible and their amino acids are absorbed more efficiently, than those of cow milk.
- Goat milk is similar in composition to cow milk, but some important differences exist in the protein structure.
- Goat and cow butter may have a similar consistency, but the flavours are different, the melting points are dissimilar, and the nutritional benefits differ. Additionally, goat milk butter is white or translucent compared to cow's milk. Some say goat butter has a grassier flavour than what they're used to with cow butter.

Nutrient	Human	Cow	Goat
Energy (kcal/100 ml)	68.00	69.00	70.00
Lactose (%)	7.30	4.70	4.10
Protein (%)	1.10	3.50	3.20
Fat (%)	4.00	3.60	3.80
Cholesterol (mg/100 ml)	20.00	15.00	12.00
Ash (%)	0.20	0.70	0.80
Calcium (%)	0.04	0.18	0.19
Phosphorus (%)	0.06	0.23	0.27
Iron (%)	0.20	0.06	0.07
Vitamin A (IU/g fat)	32.00	21.00	39.00
Vitamin D (IU/g fat)	0.30	0.70	0.70
Vitamin C (mg/100 ml)	3.00	2.00	2.00
Thiamin (µg/100 ml)	17.00	45.00	68.00
Riboflavin (µg/100 ml)	26.00	159.00	210.00

Table 4: Comparison of average milk composition

Source: Robert J. Van Saun. 2022; kcal/100 ml is a measure of energy content. 1 kcal = 1,000 calories; IU = international unit, a measure of vitamin potency; μ g = microgram, 1/1000 milligram

- One of the most incredible things about goat butter is its lower melting point. This
 means it takes less heat to melt the butter, making it more spreadable right out of the
 fridge. When used for frying, or cooking in general, the flavor difference between goat
 butter and cow disappears. When used for baking, goat milk butter may provide a
 different texture to cookies and cakes.
- One thing that most agree on is the texture of goat milk ice cream. It's intense and thick compared to cow's milk. And more often than not, goat milk gelato is considered a luxury ice cream.
- Goat cheese, often called chevre, is a decadent, full-flavored cheese with a deep, creamy texture. Aside from chevre, you can also make different cheeses, like cheddar!
- It has particular benefits in the diet of children and adults who show sensitivity or allergic reactions to cow's milk.
- Often, goat milk cheese is mixed with other milk cheeses, like cows milk, to reduce some of the "goaty" flavours that are usually identifiable in whole goat milk cheese. Chevre has the consistency of cream cheese and pairs well with crackers, bagels, and wine.
- Goat milk soap is touted as more moisturizing than regular bars of soap and more natural.
- Goat milk lotion is a fantastic type of lotion because the chemical process to make the lotion is nothing like the one used to make soap. This is why the benefits of goat milk remain intact. Goat milk lotion is typically less greasy than other kinds of cream, and it's not as harsh on the skin. In other words, goat milk lotion is quite gentle.
- According to information published in the Monitor Newspaper, Uganda (17th March 2021), goat milk contains calcium, potassium, highly-soluble less-allergenic proteins,

digestible fats and energy-producing substances, all of which are essential in boosting the immunity of the people living with HIV/AIDS.

- Some people with allergies to cow milk may find that goat milk doesn't trigger their allergies.
- "On the recommendation of our scientists and researchers, we are bringing the Toggenburg breed, a dairy goat that has been found to withstand conditions here," Dr. Beine said. He further said that a study by a Turkey's scientists Nazli Turkmen, which was published in a scientific journal Science Direct in 2017, shows that goat milk has high amounts of important substances called conjugated linoleic acids, which cause immune stimulation, growth promotion, and disease prevention.
- Many hospitals in Uganda recommend consumption of goat milk to HIV/AIDS patients because it has high protein molecules; are better absorbed than other proteins, therefore they are known to strengthen their antibodies. Scientists at the National Animal Genetic Resources Centre and Databank (NAGRC&DB) in Entebbe will start making HIV/AIDS treatment tablets from goat milk.
- Currently, goat milk is more expensive (UShs 4,000 to 8,000 per litre) compared to cow milk (about UShs 1,000 to 2500 per litre) due to urbanization.
- Non-dairy breeds of goats in Uganda have daily milk yield up to 0.5 litres while specialized dairy goat breeds, including the Nubian, Saanen, Alpine and Toggenburg under good management could give over 3 litres per day.
- Goat milk products are; cheese, flavoured goat milk powder, goat milk yoghurt, goat milk colostrum, pasteurized goat milk, yoghurt and bottled juice of milk.

7.3. Good quality milk

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

7.3. Factors affecting milk quality

Clean milk production depends on:

- milker,
- the goat,
- the milking utensils and equipment used,
- the shed including the milking place and,
- he handling of milk.

(a) The milker

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

(b) The goat

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

(c) Milking utensils and equipment

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

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



A strip cup

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

- Immediately after milking, rinse all the utensils with cool water to remove milk residues. It is rather difficult to clean utensils after the milk has dried and sticks to them. Use cool water, as hot water for rinsing will make the butterfat stick to the utensils. Rinse the milk can with cool and clean water immediately after milk delivery.
- Brush all utensils thoroughly with hot water and detergent or soap. Keep separate brushes for the inside and outside of the utensils.
- Rinse all utensils with clean, cool water to remove dissolved dirt and detergent.
- A second rinsing with a disinfectant may be considered.
- If no disinfectant is used or available, the milk cans and buckets should be left drying upside down on a rack in the sun. The sun kills bacteria and acts as a disinfectant. Rinse again with cool water before use to remove dust. If a disinfectant is used the utensils can be stored inside, upside down. Never dry utensils with a towel or cloth.
- Rinse the cloths after milking and hang them outside, if possible in the sun to dry. Once a week the clothes should be washed or boiled with hot water and soap, rinsed and left to hang drying outdoors, exposed to the sun.

(d) The shed and the milking place

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

around the shed with proper drainage and facility for storage of manure. Use insect sticky traps to control flies in the shed.

(e) Milking and milk let down

Milking deserves full attention, because it affects the yield, lactation period, butterfat percentage of the milk and the health of the udder. Milking should take place in a quiet place without shouting and yelling so that the goats feel at ease. This is achieved through a routine process with the usual milker who talks and acts quietly.

Feeding of fresh roughage or concentrates and rattling of utensils will trigger milk let down. A good cleaning and massage of the udder is necessary for the goat to feel at ease and stimulate milk let-down. The swelling of the teats is the sign to start milking. Sometimes the presence or even the suckling of a kid is necessary to stimulate milk let-down. Milking should not start before let-down has occurred. The let-down lasts for about 5 to 10 minutes and milking should be completed within that period. If the goat experiences pain or is stressed, this process will be disturbed and milk let-down will not occur.

(f) Preparation

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

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

(g) Proper milking

Full hand milking is recommended. Stripping is slower than the 'full-hand' method and may cause damage to the teat and udder tissue and hence increase the risk of mastitis. In 'full-hand' milking you close your thumb and index finger around the teat and extract the milk by squeezing progressively with each finger in turn, starting with the index finger and using minimum pulling on the teat. In this way the milk is squeezed out of the teat.



How to hand milk a goat

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

(h) Milking time

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

(i) Milking procedure

Before milking, rinse the utensils and drain them properly. The noises will already stimulate the goat.

- Offer some tasty concentrates or roughage just before milking. Dry meal concentrates can be mixed with some water to make it easier to eat and prevent dust.
- If really necessary, tie the hind legs of the goat, but prevent wounds.
- Wash hands.
- Clean the udder and the teats, preferably by rubbing gently with a dry coarse cloth. Only use water if the udder and teats are very dirty and take care to dry well with a cloth. If available, some udder disinfectant may be added to the water for cleaning. Follow the instructions for dilution carefully.
- Check the first squirts of milk of each teat in the strip cup for mastitis.
- Milk quickly paying full attention.
- Massage udder and extract the last milk.
- After milking, if possible, dip teats in a teat dip solution to prevent mastitis.
- Record the milk yield and pour milk into the can.
- Offer some roughage to the goat immediately after milking to keep her standing for about one hour. The opening of the teat will then dry and close and largely prevent the entry of mastitis-causing bacteria and dirt.
- After milking all the goats, rinse and clean the utensils.
- Clean the dairy shed and milking place.
- Deliver the milk as quickly as possible or boil and cool it.

Other important dairy goat precautions during milking

- Always house/pen the doe and the serving buck in different pens to prevent smell in the milk.
- Make the milking parlour far from the buck pen.
- Wind direction should be from milking parlour to the buck pen and not vice versa.
- Always be calm, friendly to the doe and milk at the same time every day.
- Maintain similar milking position (Back position or side position).
- The nails on the hand of the milker should be short.
- Measure and record your milk immediately.
- Wash milk equipment with hot water.
- Rinse and dry on a rack immediately after milking.
- Avoid giving feeds with strong smells just before milking and during milking e.g. silage, pineapple, waste, etc. to avoid tainting the milk.
- The hair on the flanks and around the udder should be trimmed regularly and the goat brushed occasionally.
- Use of sprays/oils/soaps with smell by milker will taint the milk

After milking tips

- Irregular milking can lead to low yields and increased chance of mastitis.
- The kid should be allowed to suck the milked teat after milking for proper emptying of teat canal.
- After milking use a teat dip containing a suitable antiseptic e.g. tincture of iodine
- If possible same person should milk always

Mastitis

- Goats with mastitis should be milked last to prevent the spread of the infection to other goats.
- Mastitis can reduce yields by at least 10 percent.
- Milk from sick goats, especially goats with mastitis should not be sold but be discarded.
- Isolate the goat with mastitis.
- Sick animals must be treated

Dry off a doe

If a doe has been served and is pregnant -special care is required during the 4th and 5th month as the embryo's gains weight rapidly.

- The does should be housed alone to avoid disturbance by the other goats.
- The doe is dried gradually, i.e milking is done normally, but the amount milked at every subsequent milking is reduced gradually until finally stopping.
- This prevents development of milk clots.

Raw goat milk downsides

The potential downsides and dangers outweigh the possible benefits of raw goat milk. Because if it is not pasteurized, raw goat milk may contain harmful bacteria such as *Listeria*, *E. coli*, and *Salmonella*.

Bacteria can get into milk through any of these mechanisms:

- a blood or udder infection in the animal
- contamination with faecal matter during or after milking
- contamination from humans handling the milk

Even raw milk from animals that appear healthy and live on farms with sanitary practices may be contaminated.

Contaminated raw milk may lead to foodborne illness with symptoms such as vomiting, diarrhoea, and stomach cramping, as well as larger complications.

While some people have mild symptoms after exposure, others may experience a serious illness that may require hospitalization and even lead to death.

Certain populations are at an increased risk of serious illness and death if they consume raw milk that contains harmful bacteria. These include:

- infants and young children
- pregnant and breastfeeding people
- older adults
- people with compromised immune systems, such as those with cancer, organ transplants, or HIV

In other words, unpasteurized dairy has been linked to 840 times as many illnesses as pasteurized products. Therefore, as an unpasteurized dairy product, raw goat milk comes with the possible downside of causing foodborne illness. Consider the potentially serious consequences before you consume raw goat milk.

7.5. Raw goat milk vs. raw cow milk

The fat and protein content in goat milk have different compositions than those in cow milk (Table 5). As a result, you may find that goat milk is easier to digest if you have trouble with cow milk. However, if you have an allergy to cow milk, you should not consider goat milk as an alternative. Most people with this allergy will also react to goat milk. Differences in

digestibility aside, goat and cow milk boast similar nutritional profiles. Below is a side-by-side comparison of the nutrients in 1 cup (240 mL) of each milk

Table 5: Comparison of composition of goat and cow milk

	Whole goat milk	Whole cow milk
Calories	168	146
Protein	8.7 grams	8 grams
Fat	10.1 grams	7.81 grams
Calcium	25% of the Daily Value (DV)	23% of the DV
Potassium	11% of the DV	8% of the DV
Vitamin B12	7% of the DV	55% of the DV

Goat milk has more calories and fat, slightly more protein, and more calcium and potassium. Cow milk, on the other hand, packs more vitamin B12. Keep in mind that these are the nutritional values for pasteurized goat and cow milk. Nutritional info for raw varieties is not available but should look similar.

7.5. Home pasteurization of raw milk

Raw milk can be a source of dangerous microorganisms that pose serious health risks. Several foodborne illness outbreaks have been traced to drinking raw milk. Home pasteurization is a good safeguard against possible risk of illness. The heat of pasteurization kills harmful bacteria such as Salmonella, Listeria, and E. coli. These disease-causing bacteria can even be in raw milk that is produced with good sanitation practices. It important to pasteurize raw milk that will be consumed by people who are susceptible to foodborne illness. That includes pregnant women, young children, older adults, and those with cancer, HIV/AIDS, and other immune system diseases. For best quality, raw milk must be heated slowly during pasteurization. Use a double boiler or place a small saucepan inside a large pan or slow cooker.

- Put water in the bottom pan and bring it to boiling.
- Pour the raw milk into the top pan. Heat it over the boiling water, stirring constantly.
- Use a meat or candy thermometer to determine when the temperature reaches 165°
 F. and keep it at this temperature for 15 seconds.
- Set the pan of hot milk in a container of cold water. Keep the water cold by adding ice.
- Continue to stir until the milk is cold, then store in the refrigerator. Raw milk can also be pasteurized in a microwave oven. Heat to 165°F using a thermometer or temperature probe. Stir the milk once or twice during the heating period to equalize the temperature throughout. Cool as directed.

Pasteurization doesn't destroy the nutritional value of milk. The milk is still an excellent source of calcium as well as protein.

7.7. Homemade fresh cheese

Ingredients

- About 4 litres of whole milk
- ¹/₄ cup white or cider vinegar
- 1 pinch salt

Step 1: Pour the milk into a large pot, and heat until the temperature reaches 195 degrees F (90 degrees C), or almost boiling. Stir constantly to prevent scorching on the bottom of the pot. When the milk reaches the temperature, remove from the heat, and stir in the vinegar. Let stand for 10 minutes.

Step 2: Line a strainer with cheesecloth, and set over the sink or a large pot or bowl. The milk should separate into a white solid part, and a yellowish liquid (whey). Stir the salt into the milk, then pour through the cloth-lined strainer. Let the curds continue to drain in the strainer for 1 hour. Discard the whey or give it to pigs.

Step 3: After the cheese has finished draining, pat into a ball, and remove from the cheese cloth. Wrap in plastic and store in the refrigerator until ready to use. Fresh cheese will usually last about a week.

7.8. Basic steps to making homemade yogurt

Step 1: Heat the milk to 180 degrees Fahrenheit. This kills whatever unsavoury microbes may be lurking in your milk and ensures you've got no remnant bacteria, pathogens, mould, or spores. When you create an environment for bacteria to multiple, you only want the good bacteria (which you introduce to the milk) to multiply. Heating the milk also creates a thicker yogurt by changing the protein structure.

Step 2: Cool the milk to 112-115 degrees Fahrenheit. After you've made the milk inhospitable for the bad stuff, you want to make it hospitable for the good bacteria – your starter mix. Use the same instant read thermometer you used when heating your milk, to know when it's cooled to 112-115 degrees.

Step 3: Add your yogurt starter – the good bacteria. Pour out one cup of warm milk and stir in either a yogurt starter or 3 tablespoons of pre-made yogurt. For a good starter, look for lactic acid forming bacteria. At a minimum you want *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

Step 4: Stir the yogurt starter with the rest of the milk. This spreads the good bacteria throughout all the milk.

Step 5: Pour the milk into jars and incubate for 7-9 hours. A consistent, luke-warm temperature is paradise for all your good bacteria and promotes their growth. The longer you incubate your yogurt the thicker and tangier it'll be. And after about 8 hours, you'll have delicious, healthy, thick and creamy yogurt.

Step 6: Place the jars in the fridge to cool and set. Cool the yogurt in the refrigerator for a couple of hours. As the yogurt cools it will get even thicker.

It should go without saying that starting with the best quality ingredients ensures you'll have the best quality end product.

SECTION 8: GOAT DISEASES AND PARASITES

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

- Provide adequate, well ventilated housing and clean the housing frequently, maintain a strict hygiene.
- Provide adequate (quality and quantity) feed and water. Insufficient or incorrect feeding weakens the animals.
- Allow sufficient time for grazing. Avoid that the goats graze too often successively on the same pasture because this increases the contamination of the pasture with parasites like worms and ticks.
- It is impossible to remain completely free of diseases and parasites. Your goats may come in contact with other animals or their excrement during grazing. Therefore, the most commonly occurring diseases and parasites are mentioned.

8.1. Signs of a healthy goat

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

- Goats are generally energetic animals and walk at a good pace. They are curious and have a bright look in their eyes. They have a good appetite and chew their cud when they have eaten enough.
- Their coat should be smooth and shiny, and the animal should not be skinny.
- If you look more closely at the appearance, start with the mucus membranes. These are good indicators of the general condition. A healthy animal has pink mucus membranes of the eye, mouth, nose and vulva.
- One of the most important life functions is the good consumption and digestion of feed and water. A good intake can be judged on the basis of the eating habits of the goat. A healthy goat also ruminates regularly while resting. A healthy goat with a good digestion produces dung of many round and firm droppings.
- Other important body functions are good blood circulation, breathing and urination, related with heart, lung and kidney processes. The 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. Calm breathing is a sign of good functioning of the lungs: for young, mature and old animals respectively 12-20, 12-15 and 9-12 times a minute. The proper functioning of the kidneys is seen by clear, yellow urine
- A practical indicator of the health is the body temperature. By holding a thermometer for at least one minute in the anus of an animal, its temperature can be measured. Young goats have a higher temperature, up to 39.0 °C = 102.2 °F. Mature goats have a temperature of about 38.5°C (101.3°F).
- The milk production, finally, is a characteristic life function of female goats. A healthy udder is soft and supple. Just before kidding it can swell up and harden without in fact being infected. The milk should have a homogenous consistency and must not smell strange. A decrease in the daily milk production is a sign that something is wrong. However, when a female goat goes into heat, its milk production may become somewhat less.

8.2. Diagnosis of a sick goat

- A sick goat can be noticed when it differs in behaviour from the rest of the herd. Especially for acute (quickly developing) diseases, the symptoms are often obvious.
- The sick animal may lose weight rapidly.
- Fast declining body condition.
- If the disease is contagious, other animals in the herd are in danger too, so immediate action is required.

- With chronic (long-term) diseases the symptoms are not as obvious. Sometimes you will only notice that a goat is losing weight and produces less. Such diseases are therefore difficult to detect.
- By comparing with other goats within the herd and of neighbouring herds, you should be able to see whether or not you are dealing with a chronic disease.
- Keeping up-to-date records will help you to detect health problems too.

Common goat diseases and parasites

Diseases/Pests	Causes	Symptoms	Prevention	Treatment	
Peste des Petits Ruminants (PPR)	The disease resembles rinderpest. It is caused by a virus. Infection takes place by inhaling the virus which is released together with the nasal mucus of sick animals.	After an incubation period of 4-5 days, 6-8 days of high fever follow. Lesions of tissue in the mouth, inflammation of the mucous membranes with excessive nasal mucus production, diarrhoea. High death rate within one week. Secondary lung infections may occur. Affects mostly young animals.	Vaccination is effective. Limit the movement of sick animals to prevent the disease from spreading.	Treatment of sick animals is very costly but possible in an early phase. Killing them is better. Secondary lung infection can be treated with drugs.	
Contagious Caprine Pleuro- Pneumonia (CCPP)	This form of contagious lung infection, is caused by Mycoplasma mycoides. It spreads by drops of nasal mucus. When kept permanently housed, the entire herd can be infected. Death rate can rise to 100%.	Rapid breathing with coughing. The animal groans when breathing out and usually secretes much nasal fluid. High fever.	A well-ventilated shed and vaccination	Arsenic preparations and antibiotics	
Haemorrhagic septicaemia	Caused by Pasteurella bacteria. All ruminants can fall victim to it, especially in humid lowland areas or at the start of the wet season. Spreads through drops of nasal mucus. After having passed through a number of victims, the bacteria gets more aggressive. Stressed animals are more susceptible. Death rate: 80-90 % of the animals infected.	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.	Preventive vaccinations are available, to be given 1-2 months before the hot/wet season when the disease manifests itself strongly.	With sulphonamides and/or antibiotics	
Foot-and-mouth disease (FMD)	This viral disease affects, mouth and hooves but also the udder and the teats of goats. The disease is transmitted by direct contact, via contaminated food,	Incubation time 3-8 days, followed by excessive saliva production and frothing at the mouth. Small blisters are formed in the mouth and on the legs.	Vaccination is possible. If only isolated groups of goats are affected, slaughtering those animals is an effective way of limiting further spreading of the	Keep them eating by offering tasty soft feeds.	
Diseases/Pests	Causes	Symptoms	Prevention	Treatment	
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	by vaginal discharge, by placenta, through the wind or by birds.	The goat has difficulty walking and limits its own movements. Animals do not die from the disease, but their production of milk and growth decreases or stops during the illness.	disease. Quarantine of sick animals, disinfection of all animals (foot baths) and prohibiting transport of animals at district or provincial level may limit the outbreak.		
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 <i>Bacillus antracis</i> . Transmission via water and food which is contaminated with blood and excrement.	Incubation time 1-3 days or more. Initial symptoms are very high fever and sudden death. After death, blood flows from the body openings	Annual vaccination campaigns are very effective. To avoid the spreading of the disease, carcasses of dead animals must be completely burnt or buried in unslaked lime (quicklime) 2 meters underground. This is to prevent possible spreading via scavengers (also dogs). Do not open the body, autopsy to determine cause of death should be done only by highly specialized personnel because of high risk of infection. It is safer to assume that the sudden death of animals was caused by Anthrax (if there is reason to suspect this) and to dispose of the cadaver as described. Consumption of this meat is very dangerous!	e Antibiotics (curative) are effective, but due to the rapid development of the disease, treatment is often too late. e l. e o o f f f d s s s	
Ecthyma or Orf	Especially in the humid tropics, this disease often occurs among goats but is usually not very serious. The disease is highly contagious through direct contact.	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.	Provide adequate housing. Vaccination is recommended for young animals in infected pens, by brushing the vaccine on a small, lightly scarified skin area.	Isolation of contaminated animals and frequent disinfection of the sores. Provide some tasty and "soft" feeds. Kids after weaning very vulnerable, especially when in the phase of changing their front teeth.	
Brucellosis	This form of infectious abortion frequently found among goats is especially well known as it can be transmitted to human beings causing Malta fever. It is caused by bacteria.	Abortion takes place in goats as a result of Brucellosis. However, the goat is not always obviously sick. The infection does, however persist and the carrier does not get pregnant again.	Vaccination. Always consider the possibility of Brucellosis if abortion occurs in a goat. If possible, let a milk sample be tested for the presence of the bacteria. For your	Kill infected animals.	

Diseases/Pests	Causes Symptoms		Prevention	Treatment	
		There is a danger that the Malta fever is transmitted to humans if they drink contaminated un- boiled milk or consume fresh goat cheese.	own protection, boil the milk before use.		
Blue tongue	This disease is caused by a virus that is transmitted by midges, which are most found in warm and wet condition	Fever and/or high temperature, tongue and gum ulcers, blue tongue	Use of midges repellent, Vaccination is available - consult animal health practitioners	Animals with blue tongue disease are susceptible to pneumonia and they must be treated. Use oxytetracyclines products only if indicated Bluetongue is a Notifiable animal disease and must be reported to either an animal health technician or a state veterinarian	
Heartwater:	This is a tickborne disease. The organisms that cause heartwater are called <i>Ehrlichia</i> <i>ruminantium</i> . The organisms are transmitted by Bont ticks, which are mainly found in hot, dry bush areas. Heartwater can result in death within 24 hours, but some cases survive two to five days.	High temperature and nervous signs which include high stepping jerky gait, shivering, walking in circles. Later, jerky, paddling movements with the legs and the head pulled backwards when the animal goes down. The dead animal's post mortem will show excessive fluid in the heart sac, lungs, chest cavity and abdominal cavity.	Try to maintain the animals' immunity by letting a small number of ticks stay on the animals all the time. However, when there are visibly many ticks on the goats, dipping about once a month may be neces sary. For vaccination, animal health practitioners must be consulted	Treat the animal early before nervous symptoms show Use oxytetracyclines product	
Mastitis	Mastitis or udder infection is a disease found all over the world. Both acute and chronic forms exist. Bacteria are usually the cause. In particular poor hygienic conditions in the shed, unhygienic and improper milking provokes the disease. Production decreases among affected animals and the milk is not suitable for human consumption.	Sick animals have a swollen udder, sometimes it is only partially affected. The milk can become lumpy and stinking. The goat does not permit its young to drink and does not like to be milked.	Hygiene during milking and proper milking technique. Use a strip cup for early detection, look for flakes in the milk.	Milk the infected udder empty as often as possible and massage it, at least 4 times per day. Inject antibiotics into the udder via the teat opening and canal after milking it empty.	

Diseases/Pests Causes S		Symptoms	Prevention	Treatment	
Pneumonia	Pneumonia is a disease of the lungs which occurs frequently in young goats. Cold and wet weather and cold draughts increase the risks of this disease. It can be caused by virus, bacteria, lung worms or fungus.	Loss of appetite, cough, dullness in appearance, nasal discharge, breathing difficulties and fever. The kids may die.	Good housing (ventilation), proper management and good feeding. Provide a good goat shed which should not contain too many animals. Deworm the goats when necessary and feed them well.	Keep the sick animal warm and separate, giving it good feed. Treatment with antibiotics may help.	
Bloat	Bloat can be caused by a physical obstruction in the throat but more often an excessive intake of feed which quickly starts to ferment in the rumen causing a sudden accumulation of frothy gasses in the rumen of the goat. Especially fresh wet green fodder which has been heating up for some time on a heap can have this effect. Excessive consumption of fresh forage legumes like alfalfa often causes this problem. Tuber crops which are no longer very fresh and sour grasses can have the same effect.	Sudden and rapid swelling of the rear of the body, especially in the left flank. Loss of appetite. They are frightened, jumpy, breath rapidly and become dazed when short of breath. They wobble and finally collapse, after which they often quickly die due to suffocation or heart dislocation.	Goats should slowly get used to a new kind of feed. Before grazing green and wet pastures, feed the animals some dry feeds (straw and hay) or put them out for grazing later in the day.	Rapid handling is essential. If this is due to the accumulation of gasses in the rumen, position the animal so that the front of its body is raised and get rid of the gasses (make the animal burp) by pushing on and rubbing the left flank. You can also try to insert a firm hose into the rumen via the gullet so that the gas can escape .Make sure that the hose does not enter the windpipe! Let the animal drink at least 0.5 litres of vegetable oil as an alternative. In serious cases, make an opening in the left flank through the skin and the wall of the rumen. Use a trocard (thick, hollow needle) or scissors which you turn a bit. Leave the trocar or scissors in the flank until the gas has escaped. Disinfect the wound.	
Ketosis (Pregnancy Toxemia)	When goats are in late pregnancy and are unable to consume enough food to keep up with the	Doe may be depressed, weak, or uninterested in food, doe has poor muscle control and balance, urine tests positive for ketone bodies, if untreated, death occurs within a few days.	Proper feeding of does throughout pregnancy	Consult a veterinarian	

Diseases/Pests Causes S		Symptoms	Prevention	Treatment
	extra demand for energy, they metabolize fat from their body stores and produce ketones.			
Caprine Arthritis Encephalitis (CAE)	Virus present in milk and colostrum of infected does	Kids experience paralysis, adults have swollen joints, paralysis, difficulty breathing difficulty and hard udders. Many does carry CAE but do not show it	Feed kids pasteurized milk and heat treated colostrum, when purchasing new goats, make sure that they are CAE free, test does for CAE before breeding and lower milk production	Consult your veterinary officer
Diarrhoea	Liquid faeces can be caused by a sudden switch from one kind of feed to another, from dry roughage to fresh, wet, young grass for example. Worms, liver fluke or a disease called Coccidiosis can also cause diarrhoea. Young and weak animals are most sensitive.	Liquid faeces. The animals become listless and eat little or not at all. They drink a lot and can be feverish. Due to dehydration they may die within several days. In case of worm infections and Coccidiosis it is possible to detect blood in the faeces. Anaemic symptoms (look at the mucus membranes) also indicate worms or Coccidiosis. A laboratory can confirm the diagnosis by checking the excrements	Good hygiene and preventing overcrowding are the best ways to avoid the disease. Provide forage in a rack or net. If possible, allow the animals to graze in the same place only 2-3 days in a row so that they do not become infected by eggs of internal parasites.	Let the animals fast for a day, keep them warm and dry. Give them unrestricted access to clean fresh drinking water, preferably boiled when used for kids. If the animals are too weak to drink, you must force them to do so! One tablespoon of salt and a handful of sugar per litre of water have a positive effect. Mash up some active carbon and give a teaspoon twice a day. In case of Coccidiosis treat all animals with sulphonamides, treat also animals that are not (yet) sick. Coccidiosis is very contagious.
White Muscle Disease	A shortage of vitamin E and selenium.	Kids are born weak or dead, healthy kids suddenly become weak and die, digestive problems in young kids and respiratory problems in young kids	Give vitamin E-selenium injections to pregnant does at three to four weeks before kidding, inject newborn kids with vitamin E- selenium when they are one or two days old and consult your veterinarian	
Johne's Disease (Wasting Disease)	Bacteria infects young goats before they are seven to eight months old. The infection thickens	Seen in animals 3 to 5 years old; older animals may be susceptible but do not show symptoms. Affected goats slowly lose weight while temperature and appetite	Purchase new or replacement animals from disease-free herds; Isolate young stock from mature animals and provide good sanitation	Diagnosis can be made by blood sample or faecal culture. The disease is fatal and there is no known cure.

Diseases/Pests Causes Symptoms		Prevention Treatment		
	the intestines and interferes with the animal's ability to absorb nutrients.	remain normal. Diarrhoea may develop during the last few days before death occur.		
Coccidiosis	Goat ingests infected faeces that contain intestinal parasites called coccidian	Kids can look and feel fine while the damage is being done. Stunted growth, usually in kids less than seven months old. Occasional diarrhoea, dull and dry coat. reduced weight gain and sudden death	Prevent faecal contamination of feed and water. Ensure all housing is sanitary, clean;	A veterinarian can check a stool sample for coccidian and sulpha drugs or Amprolium
Scours	Kids not fed colostrum soon enough after birth, dirty environment, May be caused by bacteria, viruses, or protozoa and overfeeding.	Watery or discoloured faeces, loss of appetite, fever, rough coat, weight loss and dehydration Watery or discoloured faeces, loss of appetite, fever, rough ocat, weight loss and dehydration Watery or discoloured faeces, birth, disinfect navel in tincture of iodine right after birth, avoid overfeeding milk and ensure all pens are kept clean and dry		Reduce the amount of milk given, oral antibiotics may be necessary, isolate infected kids and feed electrolytes to replace lost body fluids
Sore Mouth	Contact with virus or scabs	Small pimples that turn to scabs or blisters at the corner of the mouth, lips, or on the gums.	Difficult to prevent unless you keep a closed herd, Wash hands thoroughly after handling and do not allow children to cuddle goats because this is a zoonotic disease and can spread to humans.	lodine can be rubbed into the lesions after the scabs have been removed to dry out the area and reduce infection and sanitary precautions to prevent further infection.
Abscess	This is a swelling due to accumulated pus inside the thick wall capsule. This is caused by bacteria entering the wound or injury caused by ticks, grass seeds or thorns	Hot, red swelling and painful to touch. Middle soft spot and falling hair when swelling is at the bursting point	If an animal is affected badly and gets affected more often, culling is recommended Corynebacterium may be vaccinated for. Note that this organism is very contagious and may cause abscesses to spread (through equipment and facilities) within a herd	Cut, open and drain the abscess when it softens. Then syringe warm (boiled and cooled) water with a lot of salt (1 tablespoon of salt in a cup of water) or iodine into the wound. Spray daily with a wound aerosol. The wound must be kept opened and it must be flushed daily with warm (boiled and cooled) salt water to remove pus. Clean and disinfect the syringe after each use. The goat can also be injected with an antibiotic if it shows other signs of illness. Consult with your animal

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Diseases/Pests	Causes	Symptoms	Prevention	Treatment
				health practitioner NB: Bury or burn the material used to wipe the pus to prevent the spread of infection to other animals and people.
Internal parasites	Infection with worms is a common occurrence. Worms can be found in the lungs, stomach, intestines and liver	Production and growth may decline even while no specific symptoms of disease show. Only if the infection is severe the animals will show it. Well-fed and cared for animals suffer less from parasites. Contamination with a few worms is unavoidable, should not cause worry and can even be useful in building up resistance against those parasites. However, too many worms weaken a goat. The goat gets more susceptible to diseases and may even die.	Avoid continual grazing by large herds. Otherwise a high level of contamination of grazing areas by worms will occur due to many larvae in the faeces. Management practices, such as rotational grazing and regular treatment of the animals against worms can prevent damage. As many parasitic worms are host specific, alternating the grazing of horses and/or cattle with goats and/or sheep can lower the extent of contamination of a pasture. Cattle eat the larva of the species which have the goat as host but which cannot harm the cattle and vice versa. De-worm both nanny and kids at weaning and keep the weaned kids separate from the rest of herd, if possible on a clean pasture. The presence of worm larvae in the field builds up during the rainy season. This is the most important time to protect your animals against worms or to de- worm.	Please note: when treating animals with de-worming medicines, the prescribed dose and method of administering it must be strictly followed. Overdosing is harmful for the animal. Especially young, weak and pregnant animals are sensitive. There is often local knowledge about medicinal plants which can be applied to help get rid of worms.
Liver fluke (Fascioliasis)	The liver fluke causes much damage. It can grow to at least 3 cm long and 1.3 cm wide. The liver fluke lives in and damages the liver. By sucking blood, anaemia is caused.	The acute form, which occurs rarely, is an infection by very many flukes. The liver and stomach get badly damaged. Moisture enters the chest and stomach cavity as seen by the increased girth. The goat becomes sluggish, has difficulty breathing and can die within a	Treat the entire herd. Prevent infection by avoiding swampy places when grazing. Ensure good drainage around the water troughs. Do not use any snail-killing chemicals as they are also very poisonous for other animals! Preventive regular dosing may be justified in some areas.	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

Diseases/Pests Causes		Symptoms	Prevention	Treatment
		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.		
Roundworms and tapeworms	These worms attach themselves to the stomach or intestinal wall and live off the tissue or blood. The larvae also migrate through these tissues, therefore these worms can cause severe damage to the goat's health. They cause anaemia, infections and poor functioning of the digestion. Tapeworms which are found in goats cannot be transmitted to humans, which is possible for those tapeworms found in pigs and cattle. By properly cooking or frying the meat, infection is prevented.	Decreased appetite, less lively, a coarse dry coat, anaemia and diarrhoea or constipation because of too many worms.	De-worming and rotation of grazing areas. Avoid contact with dogs.	Using worm medication for the entire herd.
Lungworms	These are found at the mature stage in the lungs. They cause irritation of the bronchial tubes and possibly lung infection if present in large numbers. The eggs are coughed up, swallowed and get onto the land via the manure. Within one week there are already contagious larvae which are ingested with the feed. Via the intestines and blood they get to the lungs, where they mature further.	Coughing, los of weight and possibly lung infection.	See roundworms	See roundworms
External parasites	Certain kinds of flies, mosquitoes, fleas, lice, mites and ticks can, at some point of	They cause irritation of the skin which may lead to wounds. Furthermore, some of them can	General hygiene in the shed is the most important measure to avoid problems. Keep the immediate	There are o numerous kinds of acaricides (for the mites and ticks) and insecticide (for the

Diseases/Pests	Causes	Symptoms	Prevention	Treatment		
	their life cycle, parasitize on goats.	transfer diseases or internal parasites. A general characteristic of these kinds of organisms is that they multiply phenomenally fast.	surroundings of the shed free of manure and other organic waste.	others) available to keep the parasites under control.		
Note: It is important to read the product label for dosage and instructions before administering any medication, wear protective clothing when handling animals (e.g. during treatment or vaccination) and disinfect equipment that are reusable. For prevention and treatment of diseases and conditions always consult animal health technicians and veterinarians						

8.4. Biosecurity for small scale livestock production

Biosecurity is the protection of people, animals, and the environment from infectious disease, pests, and other biological threats. It refers to the proactive measures taken to exclude threats from farms that are disease free, and preventing spread of pathogens to other herds or flocks if/when a disease does occur. The ultimate goal of a good biosecurity plan is to implement easily attainable protocols that reduce problems to inexpensive and manageable occasions. The following are the key components of any biosecurity plan.

1. **Fences**: Good fences keep livestock in and wildlife out. Inspect boundary fences regularly and repair as needed. Stray stock may spread disease and feral animals introduce new pathogens to your farm.

2. Housing, equipment, and yard maintenance

- Pens should be completely emptied, cleaned, and disinfected at least annually.
- All equipment that comes into direct contact with livestock or poultry should be cleaned and disinfected periodically, including feed and water troughs.
- If sharing equipment with other farms, be sure to disinfect the equipment before using on your farm. Use your best judgement and weigh the risks carefully.
- Prevent pests and rodents by:
- ✓ Keeping area around pens free of debris
- ✓ Cutting the grass short around pens and enclosures
- ✓ Keeping feed in tightly closed containers and cleaning up spilled feed
- ✓ Using traps and bait as necessary
- ✓ Standing water should be drained

3. Introducing new stock

- Do not bring new stock to your property if they appear unhealthy.
- Avoid purchasing stock from markets and auctions.
- Obtain a health certificate if possible.
- Birds, eggs, and livestock should be sourced from farms with a solid herd or flock health program.

4. Quarantine

- Have a quarantine area available for animals new to the farm and for sick or injured animals. This should be a separate area or building to prevent bird-to-bird or animal-to-animal contact.
- Three weeks will allow time for a proper assessment of health, condition, and recuperation from transport or illness.
- Observe animals for any abnormal behaviour and signs/symptoms of disease. Presence of unusual behaviour or symptoms calls for veterinary inspection or tests.

5. Water and feed

- Water should be tested at source to ensure its suitability for livestock production at least annually.
- Design and position water bowls, troughs, and waterers to prevent fecal contamination.
- Feed or ingredients should be purchased from sources that verify its safe origin.
- Keep feed pest-free and dry, cover feed bins and feed systems to reduce the chance of contamination.

6. Work flow

- Farm owners and workers should have separate clothing and footwear for working around various animal species. These should be kept at the barn entrance.
- Use hand sanitizer or wash hands with soap and warm water before entering and after leaving livestock areas.
- Work with the youngest and most susceptible animals first.

7. Manure

- Manure should be removed from the production area regularly.
- Farms, even hobby farms and small stables, should have a manure management plan that includes collection, storage, moving, and disposing of manure to minimize chance of spreading disease.
- Tools and equipment used for manure handling should not be used for feed or bedding.

8. Herd or flock health

- Contact your Veterinary officer when livestock appear sick, mortalities are high, or production drops off without apparent reason. Low numbers of mortality should be examined by a vet if the cause of death is unknown.
- Mortality should be disposed of in a timely manner to prevent contamination of the farm environment, reduce risk of spreading disease to other livestock and humans, and prevent attraction of pests.
- When animals are stressed from parasites, weather extremes, etc., natural treatments may be less effective. Monitor carefully and resort to other options as necessary. As well, remember that sick animals benefit from remedial care.
- Vaccinate as required (keeping the necessary records).
- Pay attention to parasites. Fecal egg counts are useful in determining if treatment is necessary.
- Keep records of treatments and veterinary care.

9. Visitors

- Discourage unannounced visitors.
- All visitors must follow biosecurity protocol.
- Designate a parking area for visitors.
- Visitors should be accompanied by farm staff.
- A visitor log is recommended.
- Post "Biosecurity" and "No Entry without Permission" signs on entrance doors.
- Keep extra footwear and outerwear (coveralls, smocks, etc.) for visitors.

Biosecurity is not limited to large-scale farms. Regardless of size or production philosophy, all farms, even hobby farms, have a responsibility to prevent an outbreak or spread of animal (or plant) disease or pests. Stay on top of industry association news. Be aware of local conditions or issues as they arise. If there is a serious disease outbreak don't be the last to know!

SECTION 9: ANIMAL IDENTIFICATION

9.1. Animal identification

All livestock must be marked or identified. There are two basic types of identification: permanent and non-permanent. Permanent identification includes tattooing, ear notches or microchips. Non-permanent identification includes paint, chalk and tags. Tattooing is one method of identification that is permanent if properly done.

Tattooing is considered to be the safest and lawful way of identifying goats so far especially when your goats are lost or stolen and are found. A disadvantage about this method is that one can cut off the tattooed ears. Other methods of identifying animals such as ear tagging and ear notching can be used together with tattooing.

9.1.1. Tattooing

How to tattoo goats

- Clean the inner part of the ear lobe thoroughly so that the ink can easily fill the holes made by the tattoo pliers.
- Apply or smear the tattoo ink on the area to be tattooed.
- Make sure that the sequence of the tattooing characters is correct according to the certificate of registration.
- Press the tattooing pliers until holes appear on the skin and then release.
- Rub the ink in to the holes.
- The excess ink can be cleaned and the characters should be easily readable as black dots in the ear.

9.1.2. Ear tags

Ear tags are an easy way to permanently identify each goat in the herd. Unlike tattoos, they can be read without actually having to catch the goat. Unfortunately, unlike tattoos, they can break or be ripped out of the goat's ear. Many farmers use two ear tags because of this problem.



Goats that are shipped are required to have a scrapie ear tag and these can be used for animal identification. Before putting in the ear tag, it is important to record what ear tag number is assigned to the goat. Ensure the ear tags are inserted between the cartilage ribs on the ears. The producer whose goats have been ear tagged will have an easy-to-read identification number which can be used for herd records.

9.1.3. Microchip

The insertion of a microchip in the base of the ear or tail web of the animal is another form of permanent identification. After insertion, the microchip should be scanned to ensure that it is reading correctly. Care should be taken in recording the microchip number against the tag

number of the animal to ensure the integrity of the microchip identification. Exhibitors are required to provide their own reader at many livestock shows.

9.1.4. Ear notching

Ear notching is commonly practiced in identifying goats. It has the advantage of being visible from a distance allowing identification without the necessity of catching the animal and can accommodate numbers up to 9999. An ear notching pliers are used to put "V"-shaped notches in the edges of the ear and a hole punch is used to punch holes in the middle of the ear, if necessary. The animal is restrained and notches and holes may be treated with iodine. As this process results in bleeding, the notching pliers should be disinfected between animals to prevent transmission of any blood-borne diseases.

SECTION 10: RECORD KEEPING

Record keeping only makes sense if the information is used to evaluate the performance of the goat farm and as a basis for decision-making. The local extension officer can help with the analysis of the records and the economics of it. An annual cost-benefit analysis can be obtained by subtracting the total cost from the total income of the dairy. All of this can help plans for further developments of the dairy farm.

Technical information, like amount of concentrates fed, gives important management information when combined with prices and costs. Records about fertility, kidding interval and disease are the basis for management decisions. Technical and economic records can be combined and provide both the farmer and the extension officer with the required information about the actual situation on the farm and possible developments.

10.1. Daily records

In the daily routine of work it is convenient to use a diary to make note of all the events in order to transfer the information to the proper records at a more appropriate time. Recorded data should include:

- purchase of inputs and sales,
- price per unit and,
- total value.

Examples are: feeds, fertilizers, equipment, animals, hired labour, veterinary (and reproductive) services. Dates of events should also be recorded. Most important are milk yield, heat period, services, births, diseases and treatments of animals as well as harvests and yields of crops. Be as precise as possible with such basic data.

10.2. Animal records

On a dairy goat farm the animals are the most important so relevant information about them should be collected. This information will help you with taking action like servicing and drying off and making decisions about whether to keep the animal or dispose of it. The best thing is to keep individual records of each animal. A card is usually used to record: births, services, and production data, drying off dates, kidding intervals, vaccinations and treatments.

10.3. Financial records

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

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

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

10.4. Examples of record keeping cards

10.4.1. Herd Record

Name	Tattoo	Sex	Sire: Dam:	DOB (Date of birth)	Colour	Date Sold	Comments

10.4.2. Inventory Record

Animal ID (Name/#)	Registration #/Tattoo	Description (Breed, colour, marking, etc	DOB	Sex	Ownership Information	Purchase Price	Value
					Raised Purchased Date if purchased		
					Raised or Purchased Date if purchased		
					Raised or Purchased Date if purchased		

10.4.3. Breeding record

Dam	Sire	Date Bred	Date Birthed	No. Born Alive	No. Dead at Birth	Comments

10.4.4: Show record

Name Show	of	Location	Date Entered	Identification Number	Classes Entered	Number in Class	Comments

10.4.5: Health Record

Name/#	Breed	Sex	Age	IIIness/ Symptoms	Treatment	Date Treated	Cost of Treatment	Recovered from illness/ successful treatment

10.4.6. Death record

Name/#	Breed	Sex	Age	Date of Death	Cause

10.4.7. Feed record

Situation Description	Method of Feeding	Amount of Feed	

10.4.8. Nutritional value of feed

Name of Feed	Type of Feed	Cost of Feed	Amount fed per day	Protein %	Fat %	Fiber %

References

Abet, T. 2021. Uganda: Scientists Turn to Goat Milk to Curb HIV-Related Deaths. The Monitor paper. 17 March 2021. <u>https://allafrica.com/stories/202103180538.html</u>

Brennan K. 2017. How Youth Alive is breaking the cycle of violence and HIV in

Kampala, Uganda, December 8, 2017. <u>https://www.photographerswithoutborders.org/online-magazine/youth-alive</u>

Coffey, L.; Hale. M.; and Wells, A. 2004. Goats: sustainable Production overview. Livestock production guide.

https://ucanr.edu/sites/Mendocino/files/131469.pdf

Department of Agriculture, Forestry and Fisheries .2016. Community-Based Conservation Group. Goat training manual. Genetic Resources: Farm Animal Genetic.

file:///C:/Users/dell/Desktop/Goat%20TrainingManualbook _.pdf

FAO (Food and Agriculture Organization of the United Nations). 2010. A dairy goat production handbook for farmers. <u>file:///C:/Users/dell/Downloads/ca3399en.pdf</u>

FAO (Food and Agriculture Organization of the United Nations). 2019. The future of livestock in Uganda. Opportunities and challenges in the face of uncertainty. Rome. https://reliefweb.int/attachments/.pdf

Getaneh G, Mebrat A, Wubie A, Kendie H. 2016. Review on Goat Milk Composition and Its Nutritive Value. J Nutrition Health Sci 3(4): 401. doi: 10.15744/2393-9060.3.401

Godwell Nhamo. 2016. New Global Sustainable Development Agenda: A Focus on Africa. Volume 25, Issue 3 p. 227-241. Research Article. First published: 30 September 2016. https://doi.org/10.1002/sd.1648

Hitesh, P.; Romil, P. and Parmar, D.K. 2020. Application of solar energy for milk pasteurisation: a comprehensive review for sustainable development. International Journal of Ambient Energy. Volume 41, 2020 - Issue 1.

Kabirizi, J.; Mutetikka, D.; Aloikit-Olokit-Olaunah, C.; Wandekwa, S. and Ssewanyana, E. 2007. Feed resource utilization in intensive smallholder dairy goat production systems in the Highlands of Eastern Uganda. In: Camellius O.; Ahuya. B.; Bebe, O.; Sitawa Ogutu, J.K. 2007 Proceedings of the 6th Eastern Africa Goat Development Network (EAGODEN) Biennial Conference held at Mt Elgon Hotel, Mbale, Uganda 6-8 November 2006. pp. 71-80.

Kabirizi, J.M.L. and Ejobi, F. 2007. Indigenous fodder trees and shrubs as feed resources for intensive goat production in Uganda. Farmers' handbook. https://assets.publishing.service.gov.uk/media/57a08c1ded915d622c00112b/ZC0305a.pdf#p age=1&zoom=auto,-19,210

Kabirizi, J. M.; Lule, P.; Kyalo, G.; Mayanja, S.; Ojakol, J. F.; Mutetikka, D.; Naziri, D. and Lukuyu, B. 2017. Sweet potato silage manual for smallholder farmers. Expanding utilization of roots, tubers and bananas and reducing their postharvest losses. <u>file:///C:/Users/dell/AppData/Local/Temp/RTB-Endure-Sweetpotato-silage-Manual-for-Smallholders-Farmers.pdf</u>

Kabirizi, J.; Musasizi, M.; Businge, E.; Gumisiriza, M. and Nakayenga, D. 2021. Urban Agriculture for Food Security and Sustainable Livelihoods: A Case of Kyakuwa Farm, Makindye Municipal Council, Wakiso District, Uganda. March 2021.

Kato J. 2021. Dairy goat-keeping has more value than dairy cattle. NewVision Aug 2022. <u>https://www.newvision.co.ug/articledetails/112745/dairy-goat-keeping-has-more-value-than-dairy</u>

NAADS (National Agricultural Advisory Services). 2020. Goat farming as a business. <u>https://naads.or.ug/goats/</u>

Robert J. Van Saun. 2022. Agricultural alternatives: Dairy goat production. file:///C:/Users/dell/Downloads/dairy-goat-production.pdf

UBOS. (Uganda Bureau of Statistics). 2021. Statistical Abstract 2021. Kampala. Uganda.

https://www.ubos.org/wp-content/uploads/publications/11_2020 Statistical__Abstract_2020.pdf UNAIDS (The Joint United Nations Programme). 2021. Factsheet– World AIDS day 20021. Global HIV statistics.

https://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_en.pdf

Wayua, F.O., Okoth, M, W. and Wango, J. 2013. Design and Performance assessment of a Flat Plat solar milk pasteurizer for arid pastoral areas of Kenya. Journal of Food Processing and Preservation Volume 37, Issue 2 Pages 120-125, ISSN 1745-4549