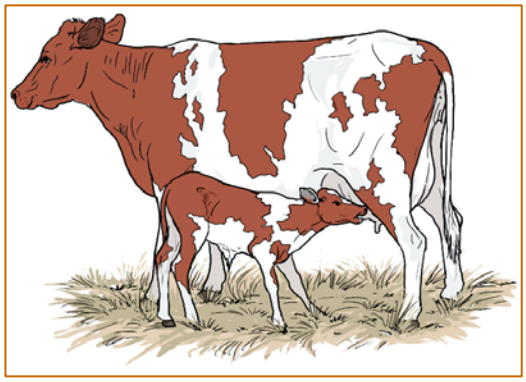
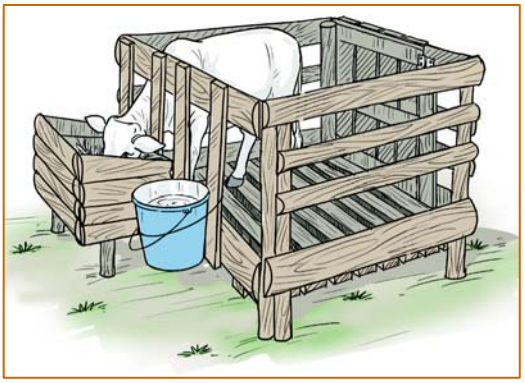
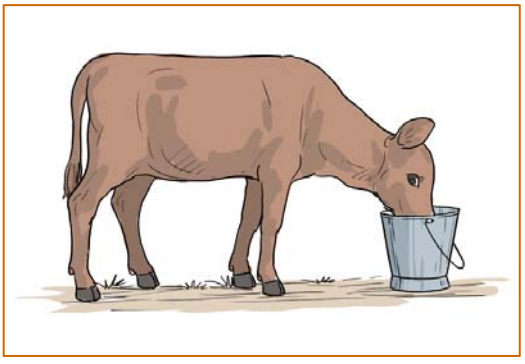
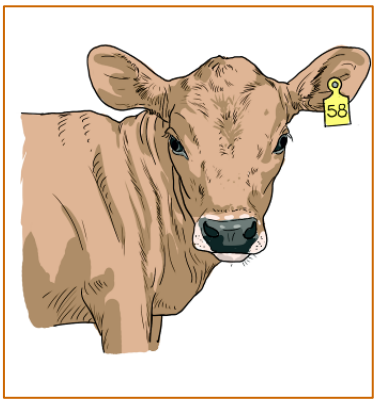
Ministry of Livestock Development

# Dairy Farmers Training Manual







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Published January 2012

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**Ministry of Livestock Development**

# Dairy Farmers Training Manual

Produced by

Ministry of Livestock Development
&
Kenya Dairy Sector Competitiveness Program

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**Acknowledgement**

We wish to record our sincere gratitude to the various stakeholders, individuals and institutions that have given us unreserved support during the preparation of this manual. We are grateful to the farmers of this country whose hard work and commitment has made the country to be one of the largest milk producers in the East and Central Africa region. We also feel indebted to the public extension workers whose mission is to empower farmers with the right knowledge so that they can improve on their daily dairy farming operations.

We sincerely acknowledge the financial support from USAID – Kenya Dairy Sector Competiveness Programme, for the development of this manual. We appreciate the technical support from the Ministry of Livestock Development, Dairy Task Force, and the many institutions and NGOs represented, who reviewed the draft of this manual and gave very constructive comments

We may not mention individually all the people and stakeholders that may have contributed in one way or another towards the development of this manual. But we sincerely thank all of them. Their contributions added value to this manual. Finally to the dairy farmers of Kenya, we believe that this manual will help you to improve your managerial skills and make you better farmers in order for you to make a contribution towards achieving our vision of 2030.

## Forward

The dairy subsector is one of the fastest growing sub-sectors within the Agriculture sector. Kenya's dairy subsector, with a population of over 3.5 million head of improved dairy cattle remains the most developed in sub Saharan Africa. Although Kenya has a highly developed private sector driving dairy marketing and processing systems, the dairy sub-sector is dominated by smallholder producers, who produce up-to 80% of the total milk produced in Kenya. However these smallholder farmers are still faced with many challenges among them inadequate extension advisory services. The dairy sub-sector is very dynamic and therefore the constant need for relevant information at the right time can never be overemphasized.

The Structural Adjustment Programmes of the World Bank implemented by the Kenya government has had a negative impact on the public extension service. The number of extension officers has gone down over the years forcing many locations and even villages to remain without extension staff, creating a big gap as far as dairy technical information flow to farmers is concerned.

This manual has been developed targeting the smallholder dairy farmers, key stakeholders, in milk production in the country. It is expected to help smallholder dairy farmers in their day to day management activities so that they can not only produce milk efficiently for higher returns but also in a clean environment and also sustainably. The dairy subsector is a major employer particularly in the rural and peri-urban areas. Improved production will therefore increase employment opportunities and contribute directly to poverty reduction and improved family or household income.

# CHAPTER 1: INTRODUCTION

## The importance of dairy farming in Kenya

Kenya has over one million small scale dairy farmers keeping over 70% of the 3.5 million dairy cattle and producing a total of 4.2 billion litres of milk every year. Apart from providing milk for consumption, hence improving the nutritional status of the rural population, the dairy enterprise has been estimated to earn famers over one hundred billion shillings annually from milk sales as well as providing employment to over 350,000 people at farm level and over 400,000 people in the informal and close to 50,000 people in the formal marketing sector.

Apart from the cash and employment, milk consumed at home provides an important source of animal protein to supplement the other foods. The cow has been used as a bank where cows and heifers may be sold at a short notice to provide cash for school fees, hospital and investment. Due to deterioration in soil fertility, manure is gaining popularity as an important byproduct for improving soil fertility to boost crop production.

Despite the fact that most dairy farmers have good quality exotic cows, milk production is low despite their potential. This low productivity has been attributed to:

1. Poor management especially inadequate feeding
2. Poor health management
3. Poor breeding management that leads to long calving intervals.

Dairy cattle in Kenya are commonly reared under three production systems:

i) Zero-grazing: The animals are housed and the farmers bring all the feed and water to the animals. The zero grazing results in higher milk yields per cow (15-30) litres/cow.

ii) Semi zero-grazing: the animals are confined but released to graze at least for a few hours per day.

iii) Open range: Here the animals are grazed in open fields throughout the day and given water and minerals in the gazing field.

iv) Majority of the smallholder farmers practice zero and semi-zero grazing. Whatever system a farmer chooses it is important to plan properly for feeding.

**Dairy cattle breeds**

The common dairy cattle breeds include the following:

**The Friesian**

**Fig. 1: A Friesian cow**

**Purpose:** Milk production

**Potential yield**: 40-60 litres milk/day

**Average body size**: Large (500-550kg)

**Description**: Black and white short haired coat, short horns

**Advantages:**

High milk production potential with low butter fat content of about 3.2%

**Note:** Milk production will depend on level of feeding and other management.

**Disadvantages:**

Heavy feeder (requirements high (90-110Kg fresh forage/day)

Susceptible to diseases, susceptible to milk fever

Susceptible to high temperatures

Large amounts of water (min 60 lts/day, more for heavy yielders)

**The Ayrshire**


**Fig. 2: An Ayrshire cow**

**Purpose**: Milk production. Ayrshire milk is referred to as "the ideal drinking milk"; it is not excessively rich, not lacking adequate fat, and it possesses desirable quantities of proteins.

**Potential yield:** 30 litres/day

**Average body size:** Large (average live-weight 450kg)

**Description:** Body colour: Brown and white patches in almost equal amounts with some cows tending to dark mahogany colour

**Advantages:**

1. High milk production potential (30 litre/day). The average milk yield from this breed in Kenya is roughly 3,000 litres in 305 days with high butter fat The cow's milk has moderate butter fat content 4.0%
2. Fairly hardy and adaptable to varied climatic zones.
3. They are relatively resistant to diseases.

**Disadvantages:**

1. Feed requirements high (90-110 kg fresh forage/day)
2. Need plenty of clean water (60 litres/day)

**The Guernsey**

**Fig. 3: A Guernsey cow**

**Purpose:** Milk production. Heifers generally come into milk at about two years of age.

**Average body size:** Medium (average live-weight 400kg).The cow weighs 450 to 500 kg.

**Description:**

1. The colour varies from yellow to reddish-brown with white patches.
2. They have a finely tuned temperament, not nervous or irritable.
3. Physically the breed has good dairy conformation and presents the visual impression of a plain animal bred for utility rather than good looks.
4. They have an attractive carriage with a graceful walk, a strong back, broad loin, wide rump and deep barrel, strong, attached udder extending well forward, with the quarters evenly balanced and symmetrical.
5. The Guernsey bull has an attractive individuality, revealing ample vigour and masculinity. It has smooth-blending shoulders showing good refinement, strength and even contour.

**Advantages:**

1. High milk production potential (25 lt/day).2. Milk has moderate butter fat content 4.3%
2. Feed requirements: Moderate (65-85Kg fresh forage/day)

3. Guernsey are efficient converters of feed to product, being of intermediate size, Guernsey produce their high quality milk while consuming 20 to 30 percent less feed per pound of milk produced than larger dairy breeds
4. Guernsey reaches reproductive maturity at an early age and can calve at 22 months of age. This provides an early return on investment
5. Guernsey are well known for having the minimum of calving complications
6. Guernsey are adaptable to all climates and management systems and lack any known undesirable genetic recessives.

**The Jersey**

**Fig. 4: A Jersey cow**

**Purpose:** Milk production.

**Average yield:** 22 litres/day and about 5.3% butter fat.

**Average body size:** Small - medium (350 Kg)

**Description:**

1. Jerseys in Kenya are typically light brown in colour, though this can range from being almost grey to dull black. They can also have white patches which may cover much of the animal. A true Jersey will however always have a black nose bordered by an almost white muzzle.
2. They have protruding eyes.

3. This breed is well known for milk with high quality - it is particularly richer in protein, minerals and trace elements than those from the larger dairy breeds. The milk is also rich in colour which is naturally produced from carotene.
4. Milk production potential is moderate (20 Lt/day), depending on feeding and management regime.

**Advantages:**

1. Feed requirements is relatively low (65-85 Kg fresh forage/)
2. Milk has high butter fat content 5.2%
3. It is hardy and adaptable to varied climatic zones
4. The Jersey's hard black feet are much less prone to lameness
5. They perform well under a wide range of systems and are well-known for their high feed conversion efficiency
6. Jerseys generally produce milk components at a lower cost compared to the other major breeds
7. They stay in the herd longer than any other dairy breed. Their milk has greater nutritional value, plus the highest yield and greater efficiency when processed into cheese and other value-added products
8. The breed has little or no calving problems, greater fertility, a shorter calving interval, and earlier maturity
9. Susceptible to milk fever and tick borne diseases

# CHAPTER 2: CALF REARING

## Introduction

The calf is the foundation of the future dairy herd which signifies the importance of proper calf rearing. Selection of replacements for culled cows can only be effective if good replacement heifers are available and in enough numbers to allow for a more rigid selection. A good feeding and management programme will result in lower death rate (mortality), replacement heifers that start production early and fast growth resulting in rapid genetic improvement.

## Management before birth

As calf management begins before birth, a few days before the calf is born, the pregnant cow is transferred to a maternity paddock, which should be near the homestead (for closer observation), well watered and free from physical objects. The signs of imminent parturition (calving) include filling of udder with milk and is turgid, vulva swollen with a string of mucus hanging from vagina. Insemination records can also be used to estimate the expected calving date.

## Management at calving

After the calf is born, ensure that calf is breathing. Should breathing not commence, the calf should be assisted (remove mucus from nostrils and if breathing does not start hold calf by hind legs upside down and swing several times). The umbilical cord should be disinfected using disinfectant (iodine or copper sulphate solution). If the calf is unable to suckle, it should be assisted and be allowed to suckle colostrum from the dam *at will* during the first week. Any excess colostrum should be milked and stored or fed fresh to other calves. During the second week of life and thereafter, the calf should be separated from dam and fed by hand.

## Feeding of the calf

The primary concern in rearing the newborn calf is to ensure it remains healthy. Feeding management should also be directed at addressing nutrient requirements and encouraging rumen development.

While designing a calf feeding program, the aim should be to reduce mortality (death) rate while maintaining a growth rate of about 400-500g/day. The growth rate will vary with breeds, for the bigger breeds the aim should be to wean calves at 3 months at approximately 80kg body weight.

## Phases of Calf Feeding

**Table 1. Four phases of the calf feeding program**

| Phase | Feed |
|---|---|
| Colostrum phase (1 - 4 days) | Colostrum |
| Pre-ruminant phase (5 days to 20 - 30 days) | Milk |
| Transition stage (Liquids & dry feeds) | Milk replacer and calf starter |
| Post-weaning stage (dry feeds) | Calf starter |

1 The aim should be to switch young calves to cheaper feeds as early as possible so that more milk can be available for sale. However, the diet must be able to promote health and growth.

## Calf Feeding Programs

1 While developing a calf feeding program the following factors should be considered.

1. The calf has low immunity at birth and therefore must be given colostrum. The colostrum has antibodies that protect the calf against diseases the mother has been exposed to and their absorption is highest within 12 hrs after birth and very low after 24 hr. As such the calf must suckle colostrum immediately after birth and if necessary it should be given using a nipple bottle. The calf depends on the colostrum antibodies for about 2 weeks when it develops its own immunity. If new animals are introduced into the herd just before calving, it may be necessary to vaccinate them against the common diseases so that they can develop antibodies and pass then on to their new born.
2. The newborn calf is dependent on milk for nutrition and growth in its early life as the rumen is not functional. The suckling reflex forms a fold (groove) which serves as a pipe for delivering milk straight from the oesophagus to abomasum in young calves (bypassing fore- stomachs). Therefore, young calves should only be fed on liquid diets as the groove will not allow solids to pass.
3. Calves secrete high amounts of lactase enzyme (breaks down lactose in milk to glucose and galactose to supply energy). The other carbohydrate digesting enzymes are low and therefore, milk which has a high lactose level should be fed to the calves. During formulation of milk replacers, the energy source should be milk lactose. Calves have no sucrase enzyme, and should not be fed on sucrose (ordinary sugar).
4. Since the rumen is not functional, the calf cannot synthesize the B vitamins and they must be supplied in the diet. The diet of the newborn calf should contain milk proteins since enzymes to break down complex proteins do not develop until 7-10 days after birth.

5. Introduce calf to solid feed

As calf is introduced to solid feed, the rumen starts developing and the calf can be weaned as soon as it can consume enough dry feed (1.5% of body weight). It should be noted that dry feed should be introduced early, as solid feed is required for rumen development. Grain based diets promote faster growth of rumen papillae (which promotes rumen function) compared to roughages.

**Calf Feeding Methods**

After the first week during which the calf is left with the dam, several methods can be used for feeding depending on ease and convenience.

**1. Single suckling**

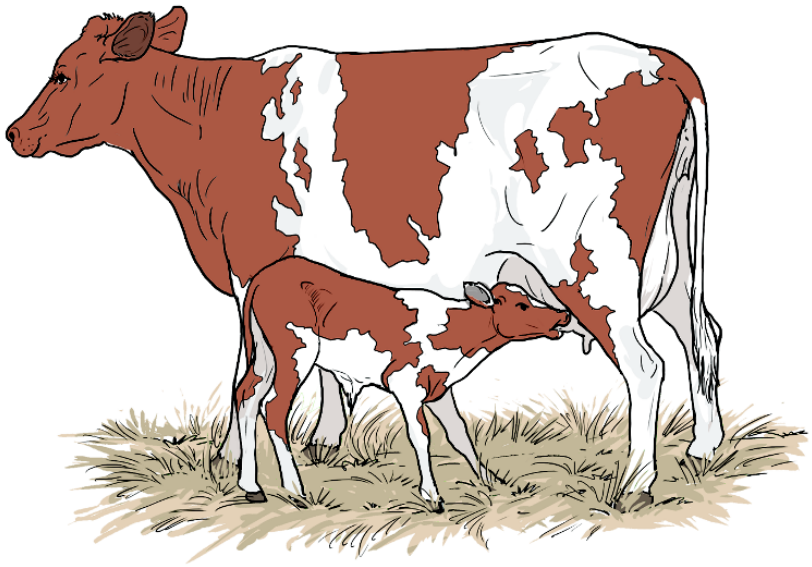


**Fig. 5: A calf suckling**

The calf is separated with the mother but during milking it is brought to to suckle. The amount of milk the calf consumes is difficult to quantify. Some farmers will allow the calf to suckle one quarter. This method is rarely used in commercial dairies. The disadvantage is that if the calf is not present, then the cow may not let down all the milk. This method is the best in terms of hygiene as the calf gets clean milk at body temperature.

**2. Foster mother or multiple suckling**

In farms where several cows give birth at the same time, one cow can be assigned to a number of calves depending on milk production. The calves suckle in turns ensuring that each calf only suckles the designated quarter. This method is not practical in small scale farms.

**Nipple suckling**

A plastic nipple is attached to a clean bottle filled with milk and the calf is trained on how to suckle. An alternative is to attach a nipple on a short plastic hose pipe and insert the same into a bucket. The calf is then trained on how to suckle.

**Bottle feeding**

The milk is placed in a clean bottle and the calf is fed directly from the bottle. This method is tedious and slow if many calves are to be fed. There is a high likelihood of milk going to the lungs via trachea.

**Bucket feeding:**

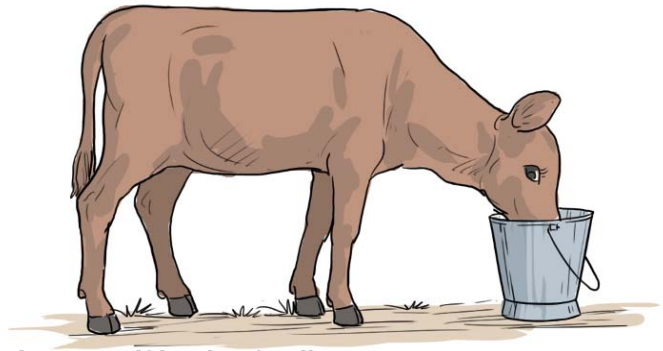


**Fig. 6 A calf bucket feeding**

This is the most commonly used method and milk is placed into a bucket and the calf is trained to drink (place finger in the milk and as calf suckles your finger it takes in milk). Stainless steel buckets, where available, should be used for hygienic reasons as plastic buckets are difficult to clean.

Whatever method is used, clean equipment should be used at all times. Sick calves should always be fed last to minimize cross contamination. Attempts should be made to feed milk at body temperature especially during the cold season.

**Feeding during first week**

Calves should be allowed to suckle obtain colostrum from their dams. If mother dies at calving or is unable to produce milk due to some condition, artificial or frozen colostrum or a contemporary mother (one that has given birth at the same time) can be used.

**Artificial colostrum**

Colostrum serves two functions in new born calves, as a source of antibodies and also a rich source of nutrients (has high amount of energy and protein compared to milk).

Artificial colostrum does not supply the antibodies but is a good source of nutrients for new born calf, e.g. composition of artificial colostrum: one egg (protein source) + half litre fresh warm water + half litre whole milk (source of lactose and milk protein) + one teaspoonful castor oil (energy) + one teaspoonful of cod liver oil (energy).

**Feeding during 2nd week to one month**:

Calves should be fed milk at approximately 10% of their body weight. Milk can be mixed with other dairy products (whey or skim milk) at this stage and should be fed at body temperature.

Commercial milk replacers can be fed at this stage if they are available and cheaper as they would result in increased profits to the farmer and increase milk for human consumption.

The milk replacer should contain 22% protein (if all protein is from milk sources) or 24% when some plant protein is included (on DM basis). Mastitic milk can be fed to calves only if it appears normal and has low levels of antibiotics. The calf should be introduced to high quality pre-starters at this time.

**Calf feeds**

Preserved colostrum

High yielding cows may produce more colostrum than the calf can consume which can be preserved and fed later. The colostrum can be preserved by several methods. The most ideal is freezing but this may not be possible in small-scale farms without electricity supply. In such cases, the colostrums may be preserved through natural fermentation (storing at room temperature). Before feeding the preserved colostrum, it should be mixed with warm water at the ratio of 2 parts colostrum to 1 part water.

Milk replacers

These are commercial products manufactured to resemble milk and are mostly used when there is no milk to feed the calf e.g where a cow is sick or died during calving. They are also used when demand and price of milk is high. Preserved colostrum should be used as much as possible before a farmer decides to use milk replacer. Milk replacers are always of lower quality than whole milk and should only be fed if they are cheaper.

Pre-starter

A pre-starter is a high quality calf feed, which should be low in fibre and is almost similar to milk replacer and is usually fed during the second and third week. It is fed in

a dry pelleted form or as a meal. It should be used early to stimulate calves to eat dry feed to enhance rumen development. It is estimated that it takes rumen growth about three weeks after the calf starts eating a handful of dry feed, thus the earlier they start the better.

Calf starter

The starter contains slightly higher fibre content compared with the pre-starter. At this stage the calf is consuming little milk and is in transition to becoming a ruminant.

**Roughage**

Calves should be offered only high quality forages early in life and supplemented with concentrates (calf starter). If hay is used, it should be of high quality, fine texture, mixed with legumes and fed *ad lib*. If they are on pasture, it would be best to always graze calves ahead of adults to control parasites. Some of the common roughages offered to calves are sweet potato vines and freshly harvested and wilted Lucerne.

**Water**

Calves should be offered fresh water in addition to milk. Lack of drinking water slows down digestion and development of the rumen, and hence the longer it takes before calves can be safely weaned.

Between three weeks and weaning, calves' water consumption usually increases and should be available all the time.

**Table 2. Example of a feeding schedule for calves.**

| Age of calf (days) | Milk kg/day | Total Milk (kg) | Calf starter (kg/d) | Roughage |
|---|---|---|---|---|
| 1 to 7 | Colostrum | | | |
| 8 to 21 | 5 | 70 | Handful | |
| 22 to 42 | 6 | 126 | 0.5 | Yes |
| 43 to 56 | 5 | 70 | 0.5 | Yes |
| 57 to 63 | 4 | 28 | 1 | Yes |
| 64 to 77 | 3 | 42 | 1 | Yes |
| 78 to 84 | 2 | 14 | 1.5 | Yes |
| **Wean the calf** | | | | |
| **Total** | | **350** | **55** | |

This programme should result in growth rate of approximately 400-500 grams per day.

**Weaning**

Weaning is the withdrawal of milk or milk replacer and the calf becomes fully dependant on other feeds. Traditionally, most dairy calves are weaned based on age, 12 weeks being the most common. Early weaning is possible if more milk is fed and calves introduced to pre-starter and starter early in life.

To minimise stress, weaning should be done gradually. The twice a day milk feeding should be reduced to once a day then to once every other day to allow the calf's digestive system to adjust to the new diet.

Criteria that have been used to determine weaning time include when calf attains twice the birth weight, when the calf can consume 1.5% of its bodyweight of dry feed and age of calf.

Early weaning (5 to <8 weeks) may be adopted to reduce the milk feeding period and labour required for calf rearing. This will require a specific feeding program using low levels of milk and high energy, high protein concentrates, preferably pelleted to stimulate rumen development. Liquid milk or milk replacer is reduced from 3 weeks of age to encourage the calf to consume and maximize intake of dry feeds.

**Calf Housing**

Housing of calves is an important aspect of calf management. Claves are housed for several reasons, the most important being protection from adverse weather conditions and predators, avoid internal and external parasites and control feeding and management.

A calf pen should be constructed where possible from locally available materials. It should be constructed to:

i) allow approximately 2 $m^2$ (1.2 X 1.5m) space per calf
ii) be well drained or bedded
iii) be well lighted (artificial or natural).
iv) be well ventilated
v) strong to stand predator invasion.

Calves can be housed permanently indoor until weaning time when they are turned to pasture or semi-indoor where they housed only at night.

The calf house can be permanent or temporary and movable. Permanent houses should be constructed such that they are easy to clean when a new calf is introduced. Temporary houses are moved from one location to another when new calf moves in.

**Design:**

A calf house floor can be on ground level or raised. If at ground level, the floor should be made of easily cleanable material (e.g. concrete) and should be bedded using straw. The sides can be made of concrete or wooden. The raised pens should have a

slatted floor. They are made of timber spaced at 1 inch to allow urine and faeces to fall on the ground. The house should be at least 1 foot from the ground.

**Fig. 7: A movable calf pen.**

In big dairies, calves can be housed individually or in groups. Individual housing is recommended during the first one month. When not possible then group housing can be done though there are several disadvantages including:

1. Difficulty in feeding and management.
2. Disease control is difficult.
3. Fights among calves - decreased growth rate.
4. Calves suckling each other which could lead to ingested hair (tend to form hair balls), blind teats and removal of disinfectant from umbilical cord.

**Fig. 8: Feeding the calf**

Raised calf pen: Suitable for newborn calves. This type of calf pen is suitable for a zero-grazing unit. It is placed inside the roofed and walled section of the unit. It may be permanent or movable.

Individual pens for calves from birth to 2 to 3 months of age are often built with an elevated slatted floor. This floor will ensure that the calf is always dry and clean.

The required minimum internal dimensions for an individual calf pen are 1200 by 800mm for a pen where the calf is kept up to two weeks of age, 1200 by l000mm where the calf is kept to 6 to 8 weeks of age and 1500 by 1 200mm where the calf is kept from 6 to 14 weeks of age. Three sides of the pens should be tight to prevent contact with other calves and to prevent draughts. Draughts through the slatted floor may be prevented by covering the floor with litter until the calf is at least one month of age.

The front of the pen should be made so that the calf can be fed milk, concentrates and water easily from buckets or a trough fixed to the outside of the pen and so that the calf can be moved out of the pen without lifting.

**General management Practices**

**Castration**

Male calves are castrated to prevent unwanted mating where male and female cattle are reared together in one herd. In addition, castrated males are easier to handle and they produce better quality meat.

Castration can be done by using an elastrator ring, burdizzo or open castration using a knife.

Knife castration: is the only completely safe method to sterilize male animals and can be done at any age by a qualified veterinarian. With this method of castration there is always a danger that the wound can become infected and the necessary precautions must be taken.

Elastrator rings***:*** The rubber ring is applied around the neck of the scrotal sack using the special instrument designed for this purpose. The testicles must be in the scrotal sack distal (away from the body of the calf) to the elastrator ring. To minimize pain when using the rubber ring method of castration, they must be applied within three days of birth.

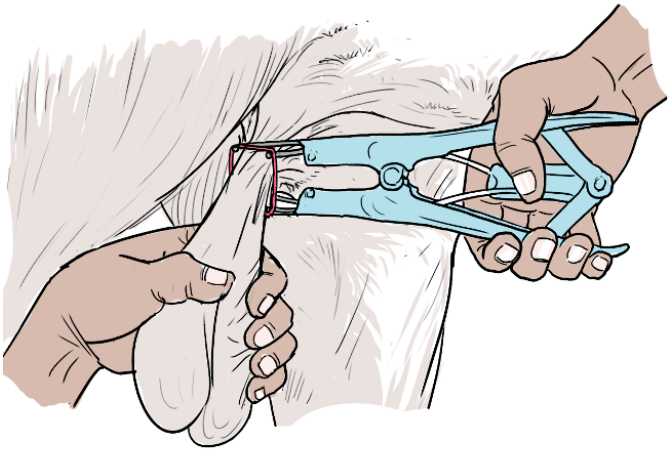


**Fig. 9: Elastrator method of castration**

*A strong rubber ring is placed around the top of the testicles thus cutting off blood supply. The testicles die off slowly.*

The burdizzo: This is an instrument used to cut off the blood supply to the testicles, causing cell death of the testicular tissues resulting in degeneration of the testicles. The best time to apply the burdizzo is three to four weeks after birth when the spermatic cords can be felt.

The burdizzo is applied to each spermatic cord separately (Figure) in such a way that the blood supply to the testicles is damaged, while circulation to the scrotal sack remains intact. Gangrene can set in where blood circulation to the scrotum is lost. To achieve these objectives, the burdizzo is applied to the individual spermatic cords at opposite sides of the scrotum, leaving a central area free for blood to circulate or applying the burdizzo at different levels on opposite sides of the scrotum.

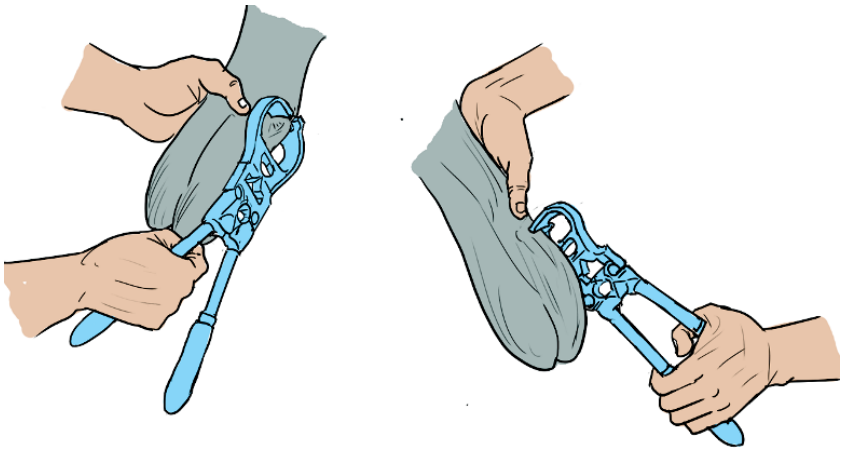


**Fig. 10: Burdizzo method of castration**

*The equipment is used to clamp and crush the top of the testicles*

## Dehorning

Horned cows are not only dangerous to people working with them, but cause a great deal of damage to hides. Dehorning also improves the animal looks.

Dehorning can be done by several methods.

Hot iron: Electric, gas or fire-heated iron is the most common in calves (4 to 6 weeks). When using this method, ensure that the killing of horn bud is effective otherwise the horn will grow again. Hot iron dehorning can be done with ease up to the age 3 months (while the dehorning iron still fits over the bud comfortably), thereafter horn growth is fairly rapid, making surgical removal necessary.

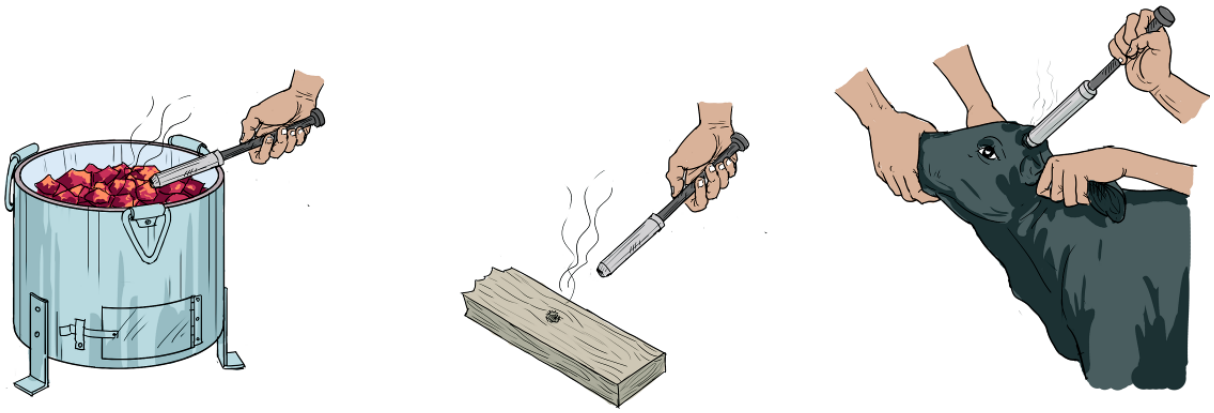


**Fig. 11: Hot iron dehorning**

Surgical method: use of saw or cutting wire: In older animals, surgical procedures must be used, especially if horns have grown to a length of 2 cm or more.

The removal of larger horns causes a great deal of pain and anaesthetics should be used with dehorning and steps taken to prevent bleeding. Blood attracts flies and blow-fly strike causes serious problems in open wounds. Once horns have grown very large, removal of the horns exposes the hollows in the skull and these must be closed to prevent infection.

## Identification

Identification of calves should be done immediately after birth to allow efficient and proper recording. Identification can be through various methods:

Branding

Hot iron - brand for a short time on the legs so as not to spoil skin. This is permanent but not common in dairy cattle.

(ii) Ear marking

a) ear notching - cut part of ear using an agreed code. This mark is permanent but exposes cow to infection.

b) ear tattooing - difficult to read and does not work in dark animals.

c) ear tagging - use an applicator, easy to read but expensive.


**Fig. 12: Three types of calf identification**

## Calf health

Most of the common health problems experienced by calves are due to poor management. Diligent feeding management and housing is therefore essential to ensure calf health is maintained. Some of the common problems associated with management practices are diarrhoea and pneumonia

## Common Diseases

Scours (diarrhoea)

Scours could be caused by nutritional disorders, viruses or bacteria. Digestive upsets leading to scours are a major cause of death in young calves. The problem can however be minimised through:

i) Ensuring calves receive adequate colostrum within 6 hours of birth and therefore acquire some natural immunity.

ii) Feeding the correct amount of milk.

iii) Early recognition, isolation and treatment of scouring calves

iv) Maintenance of hygiene and cleanliness of feeding utensils and the environment

v) Not rearing calves continually in pens, dirt yards or small paddocks that become heavily contaminated. Paddock rotation will help prevent disease.

vi) Separation of sick animals to avoid cross infection.

Close observation of calves at feeding to identify scouring animals as soon as possible for remedial treatment will prevent dehydration and secondary disease leading to chronic ill-thrift and mortality.

- Most scour incidents can be treated simply by:
- Feeding water with salts.
- Avoiding milk for 1-2 feeds. Give fresh water, concentrates and forage.

Antibiotics should not be used to treat scours resulting from over feeding or digestive upsets. Blood scours (mostly caused by coccidia) require veterinary treatment and management changes to improve hygiene.

Pneumonia

One cause of pneumonia in young calves is fluids going to the lungs via the windpipe (trachea). The first feeding of colostrum can cause problems if the feeding rate is faster than swallowing rate. If colostrum is bottle fed it is important to use a nipple that matches the calf's ability to swallow.

Greedy calves swallow large quantities of milk from the bucket, some of which may end up in the windpipe leading to pneumonia.

# CHAPTER 3: HEIFER REARING

## Introduction

Raising dairy heifers begins with choice of a bull likely to produce animals with high genetic potential for milk. A well managed dairy farm should have as many calves born every year as there are cows in the herd. Most farmers sell males calves at an early age while the females are reared as dairy replacement heifers for the herd or as heifers for sale. Raising a high number of replacement heifers allows a dairy farmer to:

i) Obtain the best replacement heifers through strict selection criteria from wide selection.
ii) Expand the dairy herd at low cost (without buying heifers or cows)
iii) Sell excess heifers to earn income.

Heifers represent the future of the herd. At the same time, they are non-productive animals incurring expenditure in terms of feed, labour and veterinary services without immediate returns. Raising heifers is a financial investment that begins to bring dividends after the first calving; therefore the goal should be to make ensure proper growth rate at minimum costs to be inseminated on time in order to realize full lactation potential later in life.

## Feeding

Heifer raising is the second largest expenditure in a farm after the milking herd, with feed costs takes the largest share. The aim should be to rear heifers to reach the desired body weight early so that they initiate puberty, establish pregnancy, and calve easily. When feeding heifers, the farmer should aim to:

i) Reduce interval between weaning and first lactation. This will increase number of calvings per lifetime (more of lactations) and lead to faster genetic improvement.
ii) Minimise mortality.
iii) Achieve a growth rate of 0.5-0.7 kg/d.
iv) Achieve first calving at 22 to 24 months of age
v) Feeding management must ensure that heifers reach target live weights for breeding at 14-16 months of age.

Combining both adequate development and early age at calving has several advantages:

i) It decreases the risk of calving difficulty.
ii) It improves lifetime milk production (days in lactation and milk production per day in lactation).
iii) It reduces rearing costs (feed, labour, etc.);
iv) It decreases total number of heifers needed to maintain herd size.

In most farms, heifers are normally the most neglected group in terms of feeding resulting in delayed calving. When heifers are fed as a group, the main problem becomes that the heifers are normally of different ages and thus aggressiveness varies. When concentrate is fed to the group, the young and weak consume less compared to others. In pasture management systems, close supervision is required due to variation in pasture quality through the seasons which may affect heifer growth rates.

Heifers can be reared on good quality pasture only as their nutrient requirements are low (growth and maintenance). Supplementation with concentrate should be at 1% of body weight. Generally the amount of concentrate given to heifers should be 1 to 4 kg depending on age (size) of the heifer and forage quality. Mineral salt supplement is recommended on a free-choice basis.

While designing a feeding program for heifers, the following should be considered:

i) Puberty (thus calving) is related to size (feeding) rather than age. The consequences of poor feeding are manifested in delayed calving resulting in delayed milk production.
ii) Feeding heifers too much energy leads to deposition of fat in mammary gland tissue displacing secretory tissue resulting in reduced milk yield. The key period in mammary gland development is between 3 and 9 months of age. During this period, mammary tissue is growing 3.5 times faster than body tissue. Heifers fed high-concentrate rations develop less milk secretory tissue in the mammary gland than heifers raised on recommended rations.
iii) Underfeeding heifers results in small bodied heifers which experience dystocia (difficult calving).
iv) Heifers calving at 24 months have a higher lactational milk yield compared to calving at an older age.
v) Size of animal is related to milk yield. For twins of same genetic makeup, the heavier one produces extra milk in a lactation.

**Growth rate (weight) versus age**

Both under- and over-feeding heifers are undesirable during heifer rearing. Overfeeding may result in obesity, low conception rate, difficult calving and low milk production while underfeeding will result in low conception rate, poor fetal growth, difficult calving and low first lactation milk yield. It is therefore important to monitor performance of heifers, particularly the body weight change and height at withers.

Growth should be such that increase in weight is accompanied by a proportionate change in height. Growth charts allow a farmer to compare the height and weight of heifers to a standard curve that represents the average for the particular breed. This tool enables the farmer to monitor heifer performance to determine whether feeding and other management practices are adequate.

Body weight and height at withers are three important measurements used to evaluate heifer growth. The weight is estimated with a weigh band and height by graduated piece of timber as shown in the picture below.

Once the measurements are taken, they are then fitted into a growth chart which is breed specific (eg below). If the body weight falls below the band (expected), then the heifer not getting enough nutrients (energy) and vise-versa. Short heifers are an indication of low protein in the diet.

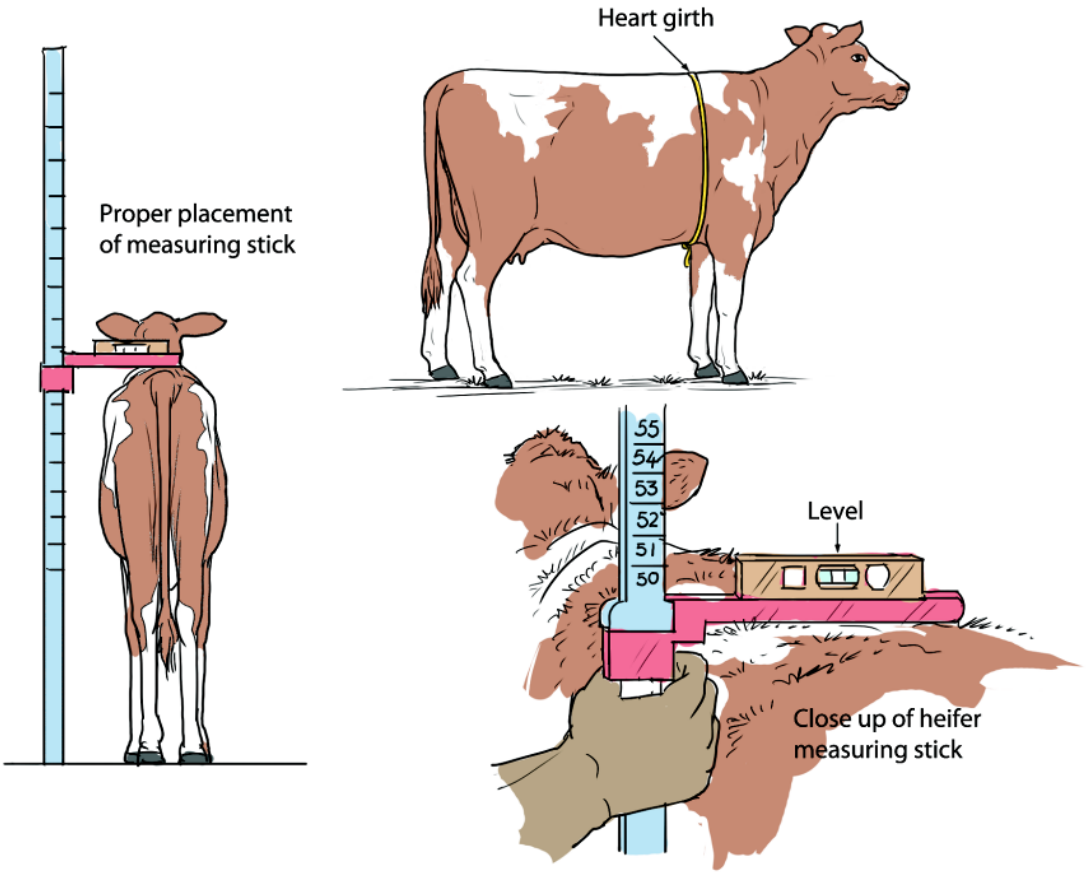



**Fig. 13: Three important measurements for evaluation of heifer growth**

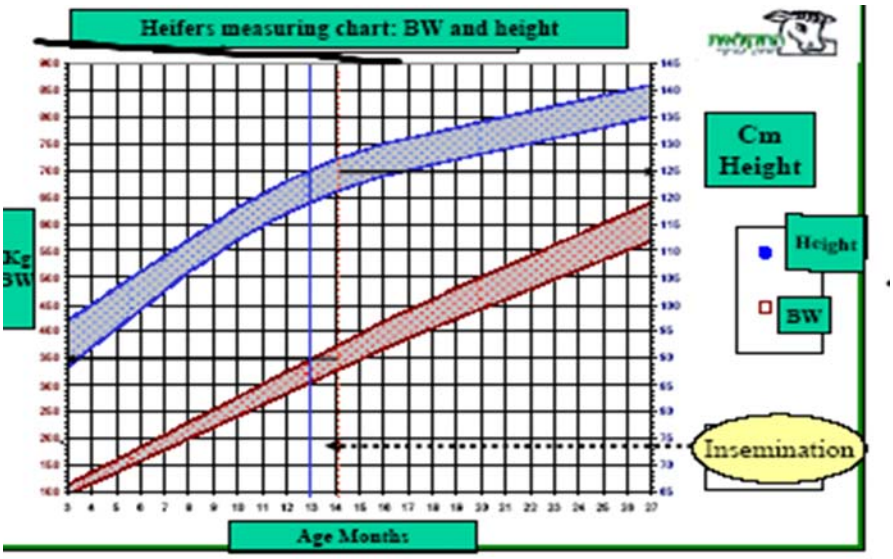



**Fig. 14: Heifer growth chart**

## Breeding

Regardless of age, puberty is reached when a heifer weighs approximately 40% of her mature body weight. Breeding however, is recommended when a heifer has reached 60% of her expected mature body weight. This is normally achieved when the heifer is 14 to 16 months old. Smaller breeds may be bred one or two months earlier than large breeds because they mature faster. Heifers in good condition and gaining weight at breeding time generally show more definite signs of estrus and have improved conception rates over heifers in poor condition and/or losing weight. Over-conditioned or fat heifers have been reported to require more services per conception than heifers of normal size and weight. The table below gives a guide on when to breed heifers:

**Table 3. Recommended age and size for breeding and calving for different dairy breeds**

| | Breeding | | | Calving | |
|---|---|---|---|---|---|
| **Breed** | **Age in Months** | **Size in kg** | **Height in cm** | **Age in Months** | **Size in kg** |
| Jersey | 12-14 | 230-275 | 112 | 21-23 | 350-375 |
| Guernsey | 14-16 | 290-320 | 120 | 23-25 | 375-400 |
| Ayrshire | 14-16 | 320-350 | 120 | 23-25 | 420-450 |
| Friesian | 14-16 | 320-350 | 125 | 23-25 | 420-450 |

*NB: There is a tremendous increase in weight during the 9 month. This is due to heifer growth and foetal weight*

## Steaming up

Once heifers are pregnant, feeding should be adequate to ensure proper development to avoid calving problems and poor first-lactation yield. Pregnant heifers may be maintained on good quality forage alone but concentrates should be given if the forage is of low quality.

During the last two months of pregnancy, the feeding regime can affect milk production during the first lactation. The exact amount of concentrates to feed before calving will depend on forage quality, size, and condition of the heifer. A rule of thumb the heifer should be fed concentrate at 1 percent of body weight starting about 6 weeks before calving with a ration balanced in protein, minerals, and vitamins.

Feeding concentrates allows the rumen bacteria to get used to digesting high levels of concentrate, which is very important during early lactation. If practical, concentrates should be fed in a milking parlour as this accustoms the heifer to the milking parlour.

Well managed heifers will have a minimum of problems at calving, but ease of calving can be affected by plane of nutrition in two ways:

i) an effect on calf size, and

ii) an effect on fatness of the dam.

Fat heifers have higher rates of difficult calving because of small pelvic openings and usually a larger-than-normal sized calf at birth. Underfed or poorly grown heifers also will require more assistance at calving and have a higher death rate at calving than normal sized heifers.

**Housing**

When considering housing for heifers, the following factors need to be considered:

- Convenience of feeding: Feeding from outside the house is desirable as it minimizes stress and risk of injuries.
- Cleanliness of the sleeping area: It should be easy to remove bedding or clean the sleeping area.
- Convenience of moving and restraining animals: Heifers go through management practices such as vaccination, dehorning, deworming, weighing, artificial insemination and they require restraint. The housing facility should meet the animal's requirements but also make it easy to handle them.

From weaning to five months, the young heifers may be housed in small groups of four to five. However, the house should be sheltered, clean, have dry bedding, good ventilation and easy access to water and feed. For zero-grazing systems, the heifers may be housed in the same unit with the mature cows, but in a separate cubical fitted with feed and water trough. If they are to be housed in a separate unit, a free stall may be used but it should include outside lots for exercise and feeding.

From the sixth month, heifers may can be kept in paddocks in the pastures but watched regularly. Shelter and fenced area must be constructed to ease animal handling and restraint but the degree of protection needed will depend on weather

conditions. Facilities for feeding supplemental feeds and minerals must also be provided.

**Health management**

Raising healthy heifers is important in all dairy production systems as health affects growth rate, fertility and hence age at first calving and milk production. Losses are also incurred in form of veterinary costs and death limiting the opportunity for selection of high quality animals and or sales. Most of the common diseases affecting calves are also important in heifer rearing and have been dealt with in the previous chapter.

# CHAPTER 4: FEEDING AND MANAGEMENT OF DAIRY COWS

## Introduction

The dairy cow is like a as a machine that converts raw materials (feed and water) into milk. The raw materials are mainly plant materials which are not edible by humans but the cow is able to convert into high quality human food.

## Qualities of a good dairy cow

Though milk production may not be 100% related with external appearance of a dairy cow, there are some physical features related to milk yield and the longevity (length of time animal is productive) of the animal in the herd. These features (Table 4) are commonly used in judging the suitability of a dairy cow from its external appearance. These characteristics should be considered by a farmer while buying, selling or selecting a replacement for dairy animals.

## Cow as a milk factory

A dairy cow can be compared with a factory. The raw materials that go into milk manufacturing are the feeds consumed by the cow. To get more milk, feed the cow on good quality feed in large quantities. The size of the factory can be compared to the size of the cow where a large factory will hold more raw materials, so will a large cow have a larger rumen.

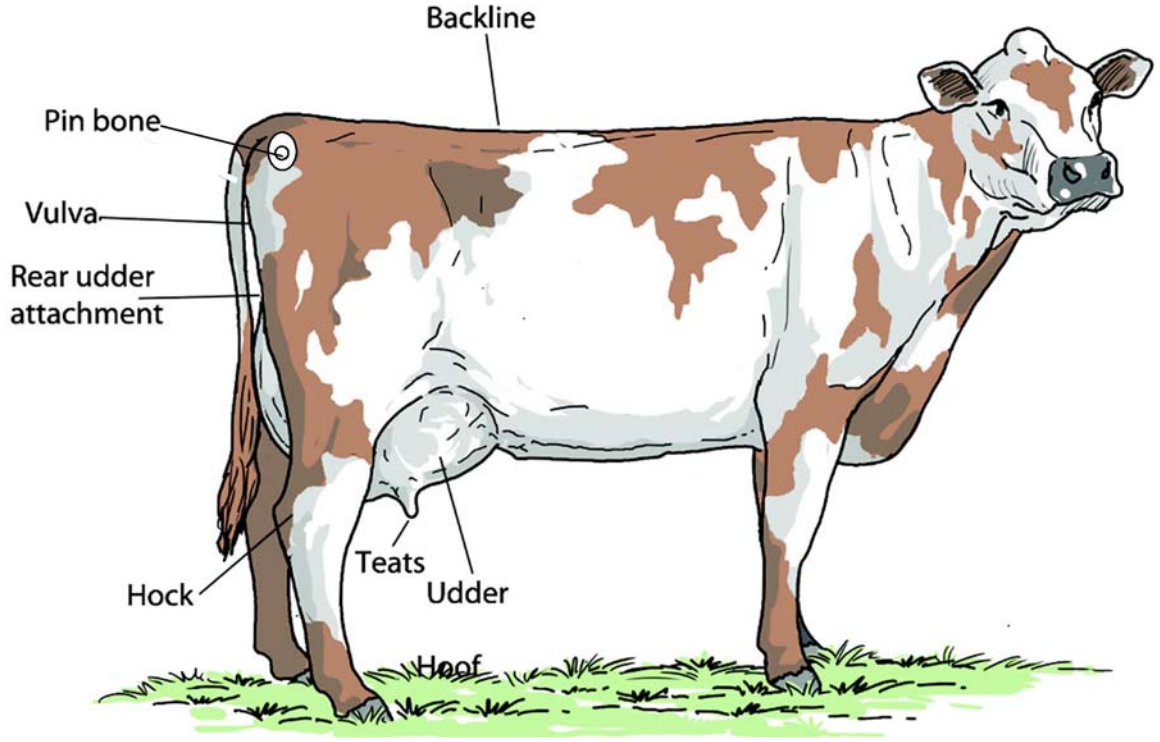



**Fig. 15: Part s of a cow**

**Table 4. Characteristics used in judging dairy cattle**

| | Character | Description | Desired |
|---|---|---|---|
| Size | Size | Stature (height in cm at rump or withers) | Jersey=120, Guernsey=125, Ayrshire=130, Friesian=135 |
| | Chest width | Distance between the two front legs | Should be large to give room for the heart and lungs |
| | Rump width | Distance between the pin bones | Should be big to ease calving and allow wide rear udder attachment. |
| Dairy Character | Angularity<br>Body Frame<br>Dairy type | Reflects the appearance that the cow has the will to milk. | Rib structure: ribs wide apart, rib bones wide, flat and long and free from excess flesh.<br>Neck: long, lean and blending smoothly into shoulders<br>Barrel: width tending to increase towards rear. |
| | Rump Angle (pelvic angle) | Angle from hooks to pins. | Pins should be slightly lower than hooks (about 1 inch). Improper angle can hinder reproductive performance and mobility. |
| | Top line (backline) | Level of backbone from shoulders to pelvis | Should be strong and level. |
| Udder | Fore udder attachment | Fore udder attachment | Attachment of fore udder to trunk should be almost level. |
| | Udder depth | Distance between bottom of udder and ground in relation to height. | Should be shallow and above the hock. Deep udder is prone to injury. Consider age and stage of lactation. |
| | Rear udder height | Distance between the vulva and udder fold | Should be attached high. |
| | Udder suspension | Udder cleft - suspensory ligament. | Should be clearly visible and continue upwards. Should be strong to keep udder firm and prevent teats from pointing outwards |
| | Teat placement | Direction of teats | Should point straight down or slightly inwards (for ease of milking) |
| | Teat length | | 5cm ideal is for machine milking, but slightly longer for hand milking. |
| Legs and Feet | Rear leg set | Angle at hock viewed from side should not be straight. | Ideally, pin bone, hock and dew claw should be in one line.<br>Should be straight from the rear. |
| | Hoof diagonal | Distance between point of toe and top of heel. | Intermediate desirable. |

Feed is converted into milk by the digestive system (stomachs and intestines) and the mammary gland. All cows can be assumed to have a similar digestive system but the capacity of the mammary gland will vary depending on size of udder and number of milk making units (alveolar cells) which are determined by the genetics of the cow. A conducive environment is required for them to function (the cow must be comfortable and free from pain), just like the workers in a factory

### Feeding

The aim of feeding of dairy cows is to maximize milk yield (by meeting cow's feed requirements) and to maintain the cow in good health.

## Nutritional requirements

Proper feeding is essential to ensure animals receive adequate nutrients for maintenance and production, and remain healthy and in good body condition. Dairy cattle must eat a balanced diet. Too little (or poor-quality feed) results in thin animals that cannot resist disease while giving too much feed is wasteful and does not make economic sense. Lack of essential nutrients will result in ill-health, failure to reach full production potential and sometimes death. For cattle, the basic types of ingredients needed are shown in Table 5 below.

- Macro ingredients. Energy supplies the body's fuel allowing the animal to move, keep warm, stay alive and be productive. Energy feeds are the main part of the diet. Protein helps young animals to grow and develop strong muscles and enables cows to produce healthy calves and adequate milk.
- Micro ingredients. Minerals and vitamins are required in small amounts and fulfil a variety of functions, including forming strong bones and maintaining the reproductive system.

**Table 5. Feeds supplying different types of nutrients**

| Type of nutrients | Cattle diets |
|---|---|
| Energy | Bulk forages and pastures – grass, hay, straw, stovers |
| | Cereal by-products (maize, maize bran and maize germ, Wheat, pollard, wheat bran, rice bran and rice polishing) |
| | Root crops – cassava chips |
| | Oil seed products |
| | Molasses |
| | Fat |
| Protein | Legume crops and forages – desmodium, sweet potato vines or callian-dra leaves |
| | Plant by-products: Mostly from extracted oil seeds (cotton seed cake, sun-flower cake, soybean cake), copra cake, groundnut cake |
| | Animal origin: Fish meal |
| | Non protein nitrogen sources (NPN): Urea, poultry litter* |
| Vitamins | Vitamin supplements |
| | Made in rumen by micro-organisms |
| Minerals | Forages |
| | Mineral licks |
| | Salt |

**Poultry litter should be properly dried and sieved to minimise amount of sawdust. Non-protein sources are converted into protein by micro-organisms in the digestive system*

## Nutrient requirements

A dairy cow, like all other animals requires energy, protein, minerals and vitamins which must be provided in the diet.

**Types of feed**

Balanced diets for cattle are made of the following:

**Bulk feeds**

Also known as basal feeds, these are fibrous plants known as forages and include grass, hay, straw and stovers (stems and leaves of tall cereals such as maize and sorghum). They provide most of the energy and bulk an animal needs and will make up most of the diet. Most contain only low or medium levels of protein. Forage forms up to 30-70% of the diet, depending on level of productivity. Using a feed trough helps to make forage accessible without wastage.

**Supplementary feeds**

These are feeds with a higher concentration of energy or protein or both, i.e. more nutrients per volume or weight of feed compared to forages. Certain forages (e.g. legumes), commercial dairy concentrates and cereal by-products are high in protein. They are fed in relatively small amounts together with the bulk feeds and are most often fed to productive animals such as lactating or pregnant cows. Protein feed should not exceed 30% of total feed since proteins cannot be stored in the body and will be In addition, extra energy is (which would otherwise be used for milk production) is used to remove the extra protein (nitrogen) from the body in form of urea in the urine.

**Table 6. Recommended crude protein levels in dairy cattle diets**

| | | | | | |
|---|---|---|---|---|---|
| Milk yield (kg/day) | 10 | 15 | 20 | 25 | 30 |
| % Crude protein in whole ration | 13 | 15 | 16 | 17 | 18 |

**Minerals**

Dairy cattle require at least 17 minerals and three vitamins in their diet for optimal milk production, reproductive performance, and herd health. Although classical mineral or vitamin deficiency symptoms are rare, in many cases under- and overfeeding of certain minerals and vitamins does occur.

Even small imbalances or deficiencies can develop into reproductive, health, and milk production problems. As herd milk production increases, it becomes more critical to balance and fine-tune the dairy herd's mineral and vitamin feeding program. Generally, the two sources of minerals include natural feeds (forages and grains) and mineral supplements to balance the minerals present in the forages and grains. Minerals can be fed using several methods.

Force Feeding: recommended way of feeding minerals to dairy cows as it eliminates

palatability problems, daily and cow-to-cow variation in intake, and over-consumption of minerals. The optimal method of force-feeding is in a total mixed ration. Another commonly used method of force-feeding is use of a grain carrier.

Free Choice**:** This method is not as accurate as force-feeding, and only trace-mineralized salt should be fed free choice.

Topdressing**:** This method is used often in stall fed cows where individual feeding practiced.

**Vitamins**

Vitamins fall into two groups: fat soluble and water soluble. The water soluble vitamins are synthesized in the rumen thus only the fat soluble (A, D, E) are required in the diet. Vitamin K is not required in the ration because it is synthesized in the rumen.

**Water**

Although water is not a nutrient as such, it is essential for life. Water can be obtained from feed and/or drinking. Lactating cows need larger proportions of water relative to body weight than most livestock species since 87% of milk is water. The amount required depends mainly on milk yield, water content of feed, amount of feed consumed, salt content of feed and the environmental temperature. Except for high moisture content, an increase in the other factors increases water requirement.

Cows will drink more water if it is availed at all times and when warm water is offered on cold days. Dairy cows suffer from a limited intake of water more quickly and severely than from a deficiency of any other dietary nutrient. Lack of water has a big effect on feed intake (especially if the feed is low in moisture) and thus on milk yield.

**Balanced Ration**

During formulation of dairy cow rations, the daily requirements for all the above nutrients must be taken into consideration. The available feed resources should then be mixed to meet the cow's nutrient requirements, which are dependent on bodyweight, milk yield, reproductive (pregnancy) requirements and growth.

A balanced ration will consist of combined feed ingredients which will be consumed in amounts needed to supply the daily nutrient requirements of the cow, both in correct proportion and amount. A ration will be balanced when all the required nutrients are present in feed eaten by the cow during a 24hr period.

Balancing a ration for animals that are not confined (grazing) is a difficult task since grazing animals can choose how much to graze and can select while grazing to improve the quality. Under these circumstances, amount of supplementation can only be estimated depending on quantity quality of the available pasture.

When a ration is not balanced, the cow eats some nutrients in excess or in insufficient amounts. Some excesses and deficiencies, if not checked, can lead to death (eg calcium deficiency resulting in milk fever). However, some imbalances are difficult to identify because they result in some degree of loss thus not permitting the cow to exploit its genetic potential.

A properly balanced ration will therefore be a mixture of all the ingredients. Total mixed ration (TMR) is a feeding method that helps achieve the mixing a balanced ration.

**Total Mixed Rations (TMR)**

TMR is defined as a mixture of all diet ingredients (roughage, concentrates, mineral supplements and additives) formulated to contain specific amount of nutrients, mixed thoroughly to prevent separation and fed at free will to the cow.

To formulate a total mixed ration, the following information is required:

Feeds (ingredients): Nutrient composition (can be obtained from laboratory analysis or estimated from text book values) and cost.

Cow: Body weight, expected milk yield and estimated amount of feed the cow can consume in one day. This allows the formulator to ensure that all the required nutrients are included in the amount of feed that can be consumed in one day.

The formulation should be done by a qualified person for the different groups of animals on the farm based on each group's requirements. As much as possible locally available feeds should be utilized.

The TMR feeding regime has several advantages compared to feeding ingredients separately as cows are able to consume high amount of feed especially in early lactation when high intakes are helpful and increase milk yields. TMR also allows greater accuracy in ration formulation and energy and protein are used more efficiently by rumen bacteria resulting in higher production.

Use of TMR improves milk fat test, minimises digestive upsets, eliminates need for

minerals supplements, allows use of less palatable ingredients and eliminates need for concentrate feeding at milking.

For the implementation of a good TMR program, there will be need for weighing equipment, estimation of dry matter content of ingredients and a qualified nutritionist to formulate the ration.

**Practical feeding**

During the formulation of rations for lactating dairy cows, the quality of the ration should be commensurate with the requirements of the cow. The requirement is directly related to the milk yield, which is in turn dependent on the stage of lactation. As such, cows in early lactation will require more nutrients compared to those in late lactation.

Since it is not practically possible to formulate a separate ration for each cow, the cows should be fed in groups (strings) with common nutrient requirements. Cows in the same stage of lactation will have almost similar requirements and can therefore the rations can be formulated according to the phase (stage) of lactation.

Phase 1: (1-70 days)

During this phase, milk production increases more rapidly than feed intake resulting in higher energy demand than intake leading to a negative energy balance. This results in mobilisation and use of body reserves and loss in body weight (negative energy). The energy is mobilised from fat reserves, protein from muscle and calcium and phosphorus from bones. However, energy is most limiting.

The health and nutrition of the cow during this phase is critical and affects the entire lactation performance. The cow is expected to achieve peak production during this phase, failure to which the lactation milk yield is reduced. Excessive weight loss may be detrimental to cow's health and reproductive performance (cow may not come on heat at the optimum time) leading to long calving intervals.

Concentrates should be added to the basal diet to increase the energy and protein content as forage alone will not be sufficient. Cows that are poorly fed during this early phase do not attain peak yield and milk production drops from week 1.

If excessive concentrates are added too rapidly (non-accustomed cows) to the ration, they can lead to digestive disturbances (rumen acidosis, loss of appetite, reduced milk production, low milk fat content). It is therefore recommended that

concentrates should be limited to 50-60% of diet dry matter, the rest being forage to ensure rumination (proper function of the rumen). If high amounts of concentrate are fed during this time buffers (chemicals that reduce the acid in the rumen and available commercially) can be helpful.

At this stage, high protein content is important since the body cannot mobilise all the needed protein and bacteria protein (synthesized in the rumen by bacteria) can only partially meet requirements. A ration with protein content of 18%CP is recommended for high yielding cows. If the cow is underfed during this stage, milk production cannot recover even when balanced rations are fed at later stages. This is attributed to the fact that cows in later stages of lactation use energy more efficiently to restore body reserves than for milk synthesis. It should be noted that cows come on first heat during this phase and regaining a positive energy balance is critical in achieving this.

Phase 2: (70-150ds)

During this phase the dry matter intake is adequate to support milk production and either maintain or slightly increase body weight. Feeding should be to maintain production peak as long as possible. Decline of 8-10%/month in milk production are common after peaking. The forage quality should still be high and a CP content of 15-18%. Concentrates high in digestible fibre (rather than starch) e.g. wheat or maize bran can be used as energy source.

Phase 3: (151-305ds)

During this phase feed intake and milk production decline. The feed intake meets energy requirements for milk production, restoration of body reserves and body weight increases. The body weight increase is due to replenishment of body reserves and, towards the end of lactation, due to increased growth of foetus. It has been shown that it is more efficient to replenish body weight during late lactation than during the dry period. The animals can be fed on lower quality roughage and limited amounts of concentrate compared to the other two phases.

Phase 4: (Dry Period: 305-365ds)

During this phase the cow continues to gain weight primarily due to weight of foetus. Proper feeding of cow during this stage will help realise the cow's potential during next lactation and minimise health problems at calving time (milk fever and ketosis). At the time of drying, cows should be fed a ration to cater for maintenance and pregnancy but two weeks before calving, the cow should be fed on concentrates in preparation for next lactation.

This extra concentrate (steaming) enables the cow to store some reserves to be used in early lactation and to adapt rumen microbial population to digest concentrates in early lactation to minimise digestive disturbances. During this phase the cow can be fed good quality forage or poor quality supplemented with concentrate to provide 12% CP. The cows should not be fed high amounts of concentrate to avoid over conditioning. If the diet is rich in energy, intake should be limited. Bulky roughages can be fed to help increase rumen size to accommodate more feed at parturition. The amount of calcium and phosphorous fed should be restricted during the dry period to 0.4% and 0.25% to minimise incidences of milk fever.

Guidelines for concentrate feeding

There are several types of commercial concentrates available in the market for feeding dairy cows, the most common being 'Dairy Meal®'. Concentrates can also be home made using locally available ingredients. It should be noted that feedstuffs available in the market e.g. bran (wheat or maize), pollard or maize germ are not similar to the mixed concentrate as they are low in protein and minerals and should be used in combination with other ingredients when supplementing forages.

The maximum amount of milk that can be produced without concentrate supplementation will depend on the quality of the pasture or forage. This has been reported to vary from 7-20 kg milk per day.

Several guidelines have been suggested on the amount of concentrate that should be fed to a cow. The only accurate one is the one calculated based on the cow's nutrient requirements and the quality of the basal diet by a nutritionist.

The example below is one of the many guidelines.

| **Guideline 1** | |
|---|---|
| **Friesian**: | |
| Yield (kg/day) | kg milk/kg concentrate |
| <18 | 4:1 |
| 18-30 | 3:1 |
| >30 | 2.5:1 |
| | |
| **Jersey/ Guernsey/ Ayrshire** | |
| <13 | 3:1 |
| 13-28 | 2.5:1 |
| >28 | 2:1 |

| |
|---|
| Up to 7 kg of milk comes from the basal forage diet<br>For every extra 1.5 kg milk above 7 kg, give 1 kg dairy meal |

**Challenge feeding:**

The lactating cow is given increasing amounts of concentrate as long as it continues to respond by increased milk production (has been referred to as lead feeding as the cow is led to produce more milk). This can be recommended only if the extra milk produced can offset the added cost of the concentrate.

Note:

Since underfeeding in early lactation can result in reduced milk production throughout lactation and delayed coming on heat, it is advisable for farmers who have limited resources to buy concentrates to feed more in early lactation and none towards the end of lactation.

**Body Condition:**

Body conditioning of dairy cows can be used to assess the feeding regimes in dairy cattle.

Body condition scoring can be carried out by the farmer through initial training and gets more accurate with experience. Several systems have been suggested but the 1-5 scoring has been the most used.

The animals are scored based on the protrusion of the hooks (tuber coxae) and the pins (tuber ischii) and the depression under the tail head (see figure and pictures below.

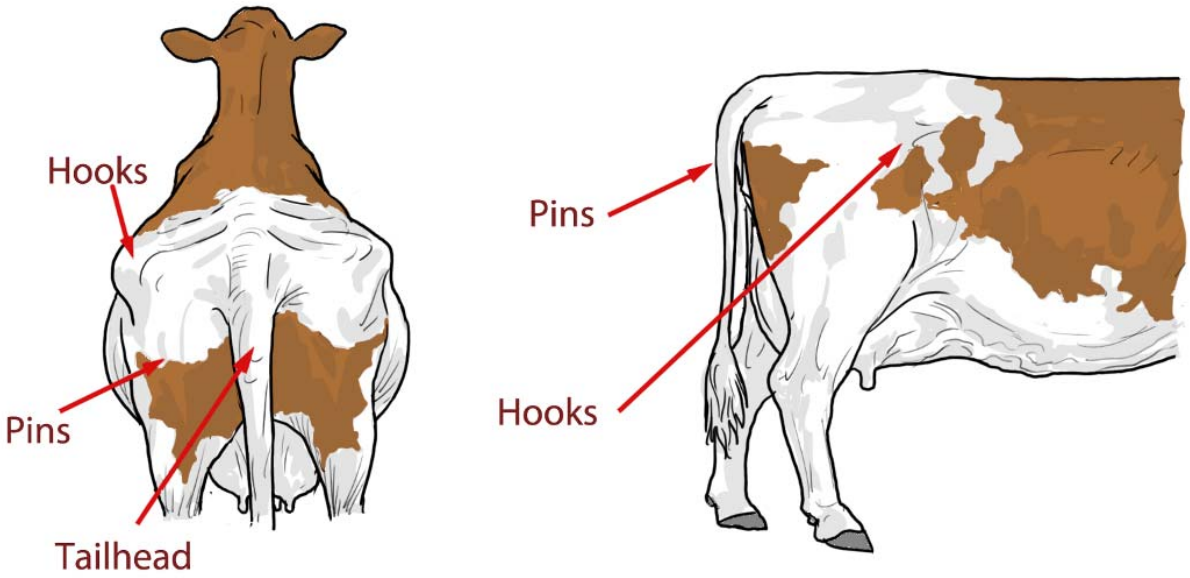



**Fig. 16: Hooks (tuber coxae) and pins (tuber ischii) protrusion in a cow**

**(a) Body Condition Score 1**

*Rump Area:* Deep cavity around tail head. No fatty tissue felt between pins. Hooks are prominent. Pelvic bone easily felt. Skin is loose.

**(b) Body Condition Score 2**

*Rump Area:* Shallow cavity lined with fatty tissue at tail head. Some fatty tissue felt under pin bone. Pelvis easily felt.

High-producing, early lactation cows should score 2.

**(c) Body Condition Score 3**

Rump Area: No visible cavity around tail head. Fatty tissue is easily felt over whole rump. Skin appears smooth. Pelvis is felt with slight pressure. Pins and hooks not prominent

**(d) Body Condition Score 4**

Rump Area: Folds of fatty tissue are visible around tail head. Patches of fat are present around the pin bones. Pelvis is felt only with firm pressure.

**(e) Body Condition Score 5**

Rump Area: Tail head is buried in fatty tissue. Skin is distended. No part of pelvis can be felt even with firm pressure.

These cows can easily get the condition fat cow syndrome.

**Fig. 17 (a) to (e): Body condition scores**

**Table 7. Desired and reasonable body condition scores of dairy cattle at critical times**

| Time of scoring | Desired score | Reasonable range |
|---|---|---|
| **Cows** | | |
| Calving | 3.5 | 3.0-4.0 |
| Peak Milk | 2.0 | 1.5-2.0 |
| Mid-lactation | 2.5 | 2.0-2.5 |
| Dry Off | 3.5 | 3.0-3.5 |

## Feed conservation

Pasture and fodder production is rain fed and thus seasonal resulting in times of plenty and times of scarcity. The aim of conservation is to harvest the maximum amount of dry matter from a given area and at an optimum stage for utilization by animals and allow for regrowth of the forage. The two main ways of conserving fodder are making hay or making silage.

## Haymaking

Hay is fodder conserved by drying to reduce the water content so that it can be stored without rotting or becoming mouldy (reducing moisture content stops microbial growth). The moisture content should be reduced to about 15%. The grasses that are very suitable for hay making include Rhodes grass, Lucerne and vetch.

## Harvesting and curing

Harvest the fodder for haymaking when flowering is 50%. At this stage protein and digestibility are at maximum, after which they decline with age. The fodder should be harvested after 2 to 3 days of dry weather so that drying will be possible. Where possible, drying should be done under shade so that the dried fodder retains its green colour, which is an indicator of quality. Turn the fodder using farm fork to ensure even drying. Check the dryness by trying to break the stem. If it bends too much without breaking, there is still much water. Legumes and grasses can be mixed to make better-quality hay, e.g. Rhodes grass + lucerne.

## Baling hay

Baling the hay allows more material to be stored in a given space. A good estimate of the amount stored makes feed budgeting easier. Baling can be manual or mechanized, manual baling being more economical for small-scale dairy farmers. Manual hay baling is done using a baling box with dimensions 85 cm long x 55 cm wide x 45 cm deep, open on both sides. If the hay is well pressed, the box will produce an average bale of 20 kg.

Hay should always be stored away from direct sun and rainfall, e.g. in hay barns. Rodents like rats should be controlled as they can damage the hay.

**Characteristics of good-quality hay**

Quality of the hay should be evident on physical examination. Good-quality hay should;

i) be leafy and greenish in colour
ii) have no foreign material mixed with it
iii) have no smell

**Silage**

Silage is high-moisture fodder preserved through fermentation in the absence of air. These are fodders that would deteriorate in quality if allowed to dry. Silage can be made from grasses, fodder sorghum, green oats, green maize or Napier grass. An ideal crop for silage making should;

i) contain an adequate level of fermentable sugars in the form of water-soluble carbohydrates
ii) have dry matter content in the fresh crop above 20%
iii) possess a physical structure that will allow it to compact readily in the silo after harvesting

Crops not fulfilling these requirements may require pre-treatment such as:

i) field wilting, to reduce moisture
ii) fine chopping, generally 20–25 mm preferred to allow compaction
iii) use of additives, to increase soluble carbohydrates

**Harvesting stages**

Napier grass should be harvested at about 1 metre when protein content is about 10%. Maize and sorghum should be harvested at dough stage, that is when the grain is milky. The grains will provide water-soluble sugars and molasses is not necessary when ensiling. When ensiling napier grass, molasses should be added to increase the sugar content. To improve silage quality, poultry waste and legumes like lucerne and desmodium may be mixed with the material being ensiled to increase the level of crude protein.

**Types of silos**

A silo is an airtight place or receptacle for preserving green feed for future feeding on the farm. Silos can be either underground or above ground, the qualification

being that the silo must allow compaction and be air tight. Five types are described here: tube, pit, above-ground, trench and tower.

Silage can be made in large plastic sacks or tubes. The plastic must have no holes to ensure no air enters. This is popularly referred to as *tube silage*. Silage can also be made in *pits* that are dug vertically into the ground and then filled and compacted with the silage material.

An *above-ground silo* is made on slightly slanted ground. The material is compacted and covered with a polythene sheet and a layer of soil is added at the top. When finished, it should be dome-shaped so that it does not allow water to settle at the top but rather collect at the sides and drain away down the slope.

The *trench silo* is an adaptation of the pit silo, which has long been in use. It is much cheaper to construct than a pit silo. Construction is done on sloping land. A trench is dug and then filled with silage material. This method is ideal for large-scale farms where the tractor is used. Drainage from rain is also controlled to avoid spoiling the silage.

*Tower silos* are cylindrical and made above-ground. They are 10 m or more in height and 3 m or more in diameter. Tower silos containing silage are usually unloaded from the top of the pile. An advantage of tower silos is that the silage tends to pack well due to its own weight, except for the top few feet.

**Qualities of good silage**

Well-prepared silage is bright or light yellow-green, has a smell similar to vinegar and has a firm texture. Bad silage tends to smell similar to rancid butter or ammonia. Natural microorganisms turn the sugars in the plant material or any added as molasses into weak acids, which then act as a preservative. The result is a sweet-smelling, moist feed that cattle like to eat once they get used to it.

**Storage and feeding**

Tube silage should be stored under shade, for example in a store. Rodents like rats that could tear the tube need to be controlled. When feeding, open the tube and scoop a layer and remember to re-tie without trapping air inside. When feeding from the pit, scoop in layers and cover after removing the day’s ration, making sure the pit is air tight. Drainage from the top should be guided to avoid rainwater draining into the pit.

When feeding from the above-ground method, open from the lower side of the slant, remove the amount you need for the day and re-cover it without trapping air inside.

To avoid off-flavours in milk, feed silage to milking cows after milking, not before, or feed at least 2 hours before milking.

**Losses**

Nutrient losses may occur during silage making. In the field during cutting, losses due to respiration during wilting will be about 2% per day. If it rains, leaching may cause some loss.

Overheating due to poor sealing gives a brown product, which may smell like tobacco and result in severe damage to nutrients e.g. proteins.

Effluent losses of 2–10% that occur from moisture seepage contain soluble and highly digestible nutrients; seepage should be avoided by wilting the herbage.

**Silage additives**

During silage preparation, different types of additives can be added to improve the quality. These include *fermentation stimulants*. Some crops may not contain the right type or the right number of lactic acid bacteria. Bacterial inoculants and enzymes can hasten and improve fermentation by converting carbohydrates to lactic acid. Most inoculants contain *Lactobacillus plantarum*.

*Fermentation inhibitors* include acids such as propionic, formic and sulphuric. Inorganic acids are more effective but are strongly corrosive thus not recommended. Of the organic acids, formic is more effective than propionic, lactic or acetic.

Substrate or nutrient sources (grains, molasses, urea or ammonia) are used when there are insufficient soluble carbohydrates in the material to be ensiled (e.g. legumes, Napier grass, crop residues). They are also used to increase the nutritive value of the silage. Molasses can be added at about 9 kg/t of silage.

***Note:*** Use of additives is not a prerequisite for making good silage, but it is good for problem crops.

**General management of dairy cows**

The management practices in a herd of dairy cows can be split into 4 periods. After first calving, a dairy cow at any one time will be the following periods:

- Reproductive: Service period (calving to conception) or Gestation period (conception to calving) = Calving Interval

- Productive: Lactation period (calving to drying) or Dry period (from drying to next calving) = Calving Interval

Some management practices are period specific while some are performed during all the periods. There is an overlap in some of the periods: a lactating cow can be pregnant or not pregnant and a pregnant animal can be lactating or dry.

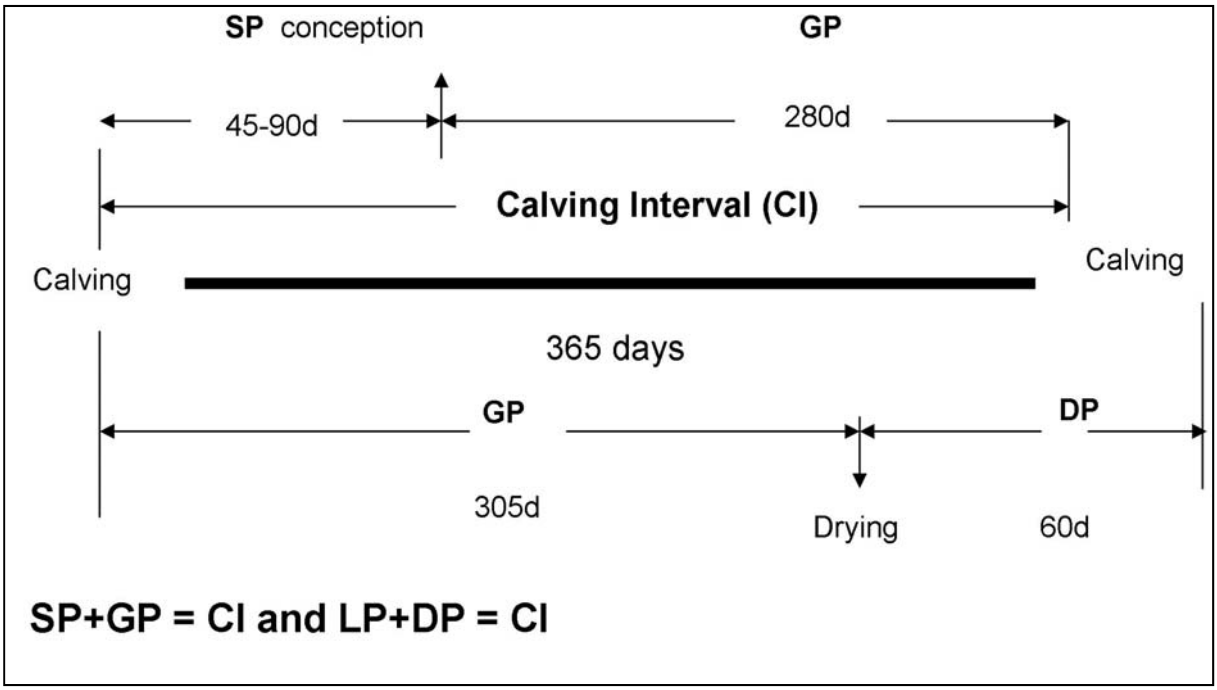



**Fig. 18: The different periods of the dairy cow cycle.**

**Service period:** From calving to successful conception

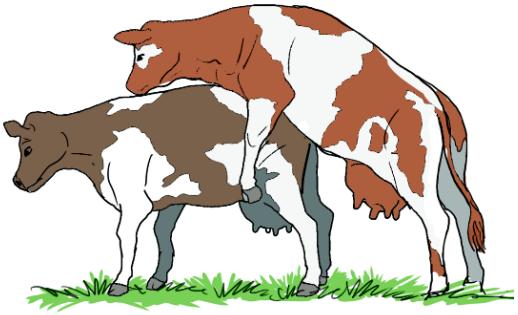
This period is expected to last between 45 and 90days. During this period, the cow is expected to come and heat and be bred. The main management practices are therefore heat detection and successful mating (natural or artificial).

**Heat detection:**

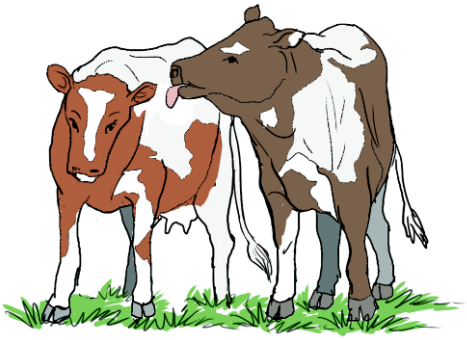
This is an extremely important exercise as a missed heat translates into a wasted 21 days while efficient heat detection makes it possible to serve the animal at the right time. The average heat interval is 21 days with a range of 18 to 24 days. Duration of heat is 24 to 36 hours in exotic and crossbred cows.

Several methods are used to detect heat. The most commonly used by farmers are behavioural signs and physical changes.

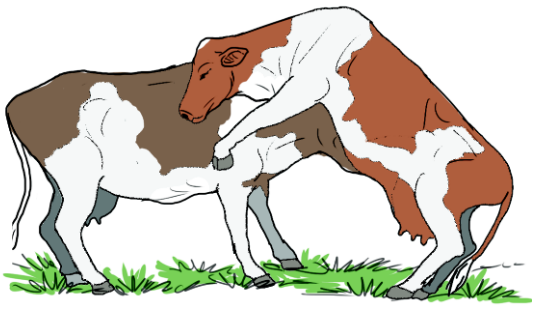
| Early heat | Standing heat | After heat |
|---|---|---|
| • Increased nervousness/ restlessness<br>• Mounting other cows<br>• Swollen vulva<br>• Licking other cows<br>• Sniffing other cows and being sniffed<br>• Reduced feed intake | • Standing to be mounted<br>• Clear mucus discharge<br>• Sharp decline in milk production<br>• Tail bent away from the vulva<br>• The animal may stop eating | • Dried mucus on the tail<br>• Roughened tail head<br>• The animal refuses to be mounted<br>• Streaks of saliva or signs of leaking on her flanks |
| Early signs: Watch the cow closely | Best signs: Take the cow for service | Late signs: Keep record |



***(a) Standing to be mounted*: The positive sign of heat is standing to be mounted. The cow in heat stands to be mounted and does not move away**



***(b) Licking:* Both cows may be in heat**



***(c) Mounting head to head:* The cow mounting is in heat**

**Fig. 19 (a) to (c): Behavioral signs of heat in cows**

**Aids to oestrus detection:**

I. Vasectomised or teaser bulls - These are surgically prepared bulls which are intact but will not impregnate the cow (teaser bulls have their penis deviated such that they will mount but cannot deposit semen in the cow). Animal with nutritional deficiencies (eg Calcium and Phosphorous mainly during the dry season) may exhibit silent heat (no behavioural signs), which can be detected by vasectomised bulls.

II. Records – can be used to predict date of expected heat.

III. Pressure sensitive (commercially available) mount detectors. They are glued to the rump (back) of the cow suspected to be on heat and are activated by pressure of mounting of the cow by others.

IV. Detection of ovarian changes: Use commercial kits to detect fall in progesterone levels in milk.

**Note:** Heat should be checked three times a day.

Numerous studies indicate poor oestrus (heat) detection is the most common cause of prolonged inter-calving intervals in dairy cattle so herd managers must insure that animal attendants responsible for this are competent. An oestrus detection efficiency of 75 % would represent outstanding performance, a standard achieved in very few herds. Even 60 % efficiency would be somewhat above average with perhaps a 45 % detection rate representing about the average for commercial dairy farms.

Many herds, however, realize only 20 to 30 % efficiency, a rate that results in far too many days open. This poor detection efficiency results in greatly prolonged inter-calving intervals and high involuntary culling for reproductive failure. Unfortunately, this latter situation is encountered on many dairy farms all over the world.

**Mating:**

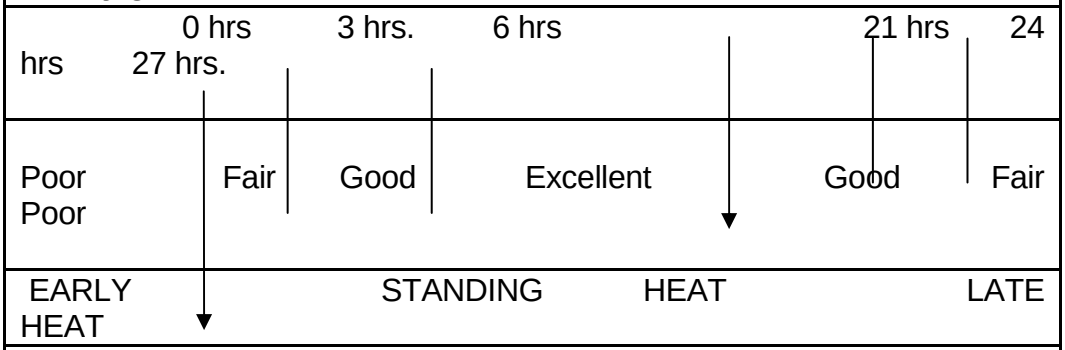
Once heat has been detected, cows should be mated.

**When to serve:**

Present the cow for insemination at the right time to increase the chances of conception. Below is a guide as to the best time to present the cow for insemination:

| **AM – PM Rule:** | |
|---|---|
| **Standing heat observed** | **Present for insemination** |
| Before 9 am | Late evening the same day |
| Late afternoon or evening | Early next morning |

**Hourly guide:**




First observation of standing heat

**How to improve breeding performance**

- Serve cows 50 to 75 days after calving.

- After insemination, check 19 to 21 days later for any heat signs.
- Carry out pregnancy diagnosis six to eight weeks after the last insemination.
- Maintain good nutrition with balanced rations and adequate mineral supplementation for good fertility.

**Breeding methods**

Breeding can be achieved through natural service or artificial insemination, and irrespective of the method, the aim should be to achieve increased chances of conception.

**Natural service**:

This is where the cow is taken to a bull and left for some time for the bull to serve.

The advantages of this method are:

- The cow has an opportunity to be served more than once; this increase the chance of conception.
- The semen is fresh and of good quality since there is no handling.
- Where the farmer does not own a bull, cost of service is lower compared to A.I.

Natural service has the following disadvantages:

- Rearing a bull is not economical especially to a small holder farmer
- There is risk of spreading breeding diseases.
- There is risk of inbreeding if the bull is not changed frequently
- There is no opportunity to select the type of bull the farmer wants.

Increasing the chances of conception through natural service:

- Take the cow to the bull as soon as it is detected to be in heat and leave it for at least twelve hours.
- Young inexperienced heifers should be mated with old experienced bulls.
- Young inexperienced bulls should be given to old experienced cows.
- The bull should be kept fit and in good health particularly the legs and feet.

Natural mating can be done in two ways:

Free/pasture mating - This method of mating is practised by farmers who own bulls which run full time with the cows. One bull can serve 20-25 cows.

It has the advantage no no heat detection required and disadvantage of lack of accurate records and possibility of transmission of reproductive diseases e.g. brucellosis.

Hand mating- The bull is enclosed in it's pen and the cows are brought in when they show signs of heat. Most small-scale farmers will practice this method since bulls are owned by few farmers and others bring their cows for service at an agreed fee.

The advantage is keeping accurate records while the disadvantage is the farmer has to detect heat.

**Artificial Insemination**

Artificial Insemination popularly referred to as AI is one of the breeding methods that has contributed to the development of the dairy sector in the last sixty years in Kenya and also worldwide. The process of artificial insemination starts with a healthy bull, that is disease free and producing ample quantities of high quality semen. The fertility of the cow is also important, the competency of the inseminator and a clean environment. Farmers are encouraged to use semen from proven bulls which is obtained from AI centres and registered service providers.

Benefits of Artificial Insemination

1. Prevention of venereal diseases
2. Indefinite preservation of genetic materials of low cost enabling wide testing and selection of bulls
3. Enhances genetic progress as best bulls are used widely nationally and internationally
4. Small scale farmers through AI can access good bulls cheaply
5. One is able to select the bull of interest.
6. When handled properly, there is no chance of spread of breeding diseases.
7. It is easy to control inbreeding.
8. A.I. is the best method of improving the genetic make-up of local breeds because it enables semen from the very best bulls to be widely available.
9. It is cost effective since the farmer does not have to rear a bull.

Disadvantages of AI

1. It requires very accurate heat detection and proper timing of insemination for greater chances of conception.
2. The inseminator must be trained on the technique.
3. It requires high investment in equipment.

**Factors affecting rate of conception:**

**The fertility chain**

Successful conception is dependent on several factors, which form a fertility chain. The concept of the chain is that it is only as strong as the weakest link. Therefore all the links in the chain should be strong enough to strengthen the whole chain, as one weak link results in no conception.

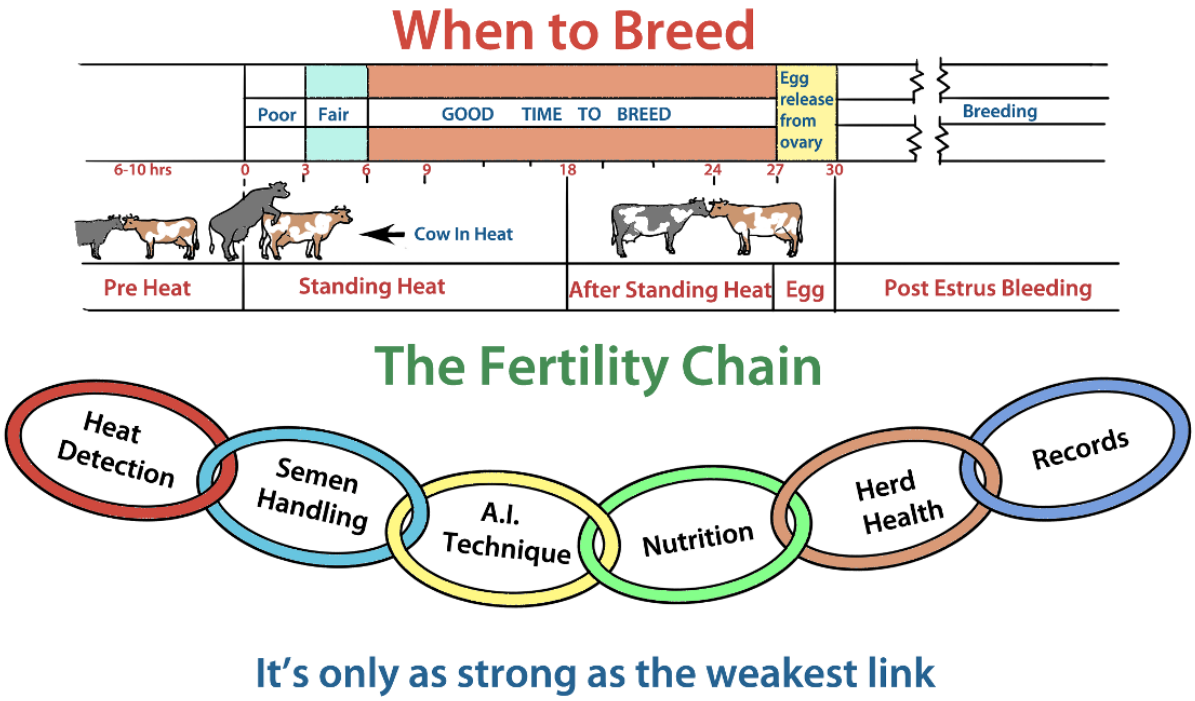



**Fig. 20: The fertility chain**

### Heat detection and time of service

This depends on whether natural service or artificial insemination is used. A cow in 'standing heat' stands for mounting by bull or another cow.

In practice, a cow showing heat in the morning should be inseminated in the afternoon, while those showing heat in the evening should be inseminated the next morning.

### Semen quality and handling

To maintain a good dairy herd, the farmer must use semen of proven bulls all the time. The semen must be obtained from agents or service providers registered by

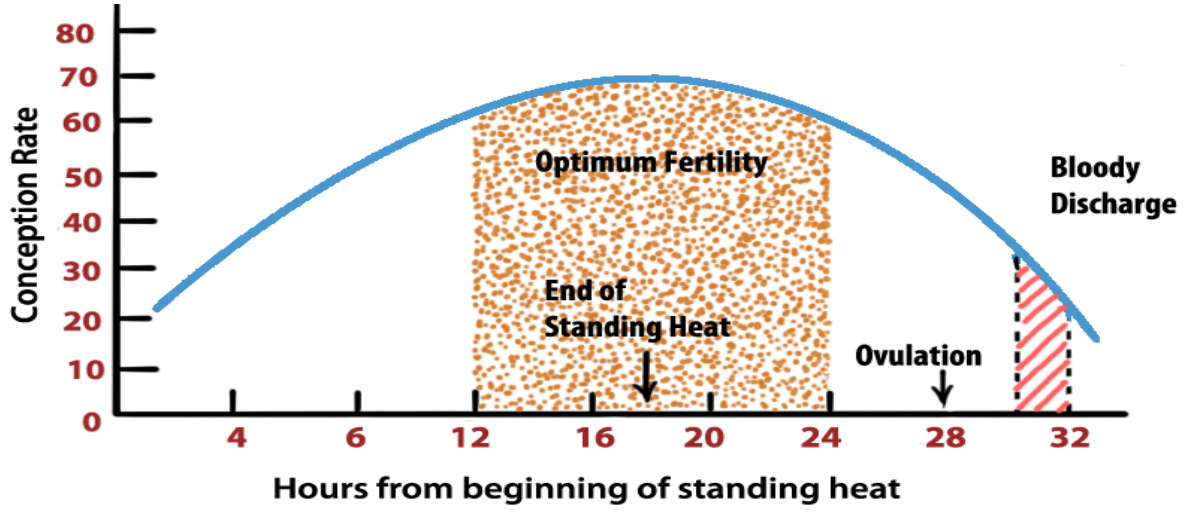



**Fig. 21: Hours from beginning of standing heat**

the veterinary department. AI can spread disease if attention is not paid to the health status of the bull. All bulls at approved AI centers are constantly being screened for any disease to ensure that semen collected from them is safe and disease free.

The spermatozoa should be fertile, of good concentration, high motility and of normal morphology (structure).

**A.I. Technique**

Farmers should only use registered inseminators who are competent and know how to handle semen and apply proper AI techniques. Handling semen involves retrieving semen from the tank without damaging what remains in the tank, thawing and loading an AI gun and successfully inseminating the cow with semen that is still alive and viable.

**Nutritional factors.**

Nutrition is the single most important factor that affects cow fertility than any other factor. Low protein and low energy intake causes delayed puberty, silent heat and infertile ovary. Vitamin A and D are heavily involved in reproduction and their deficiency affects conception and pregnancy. Overfeeding results in fatty ovaries, low hormonal secretion hence low conception rate.

Note that today's fertility is a reflection of the cow's environment and management during the previous two or three months. Also decisions made today can affect a cow's fertility for several months to come.

**Normal health of female genital tract.**

The cow should be maintained in good health condition. Any disease of the female reproductive tract affects conception rate. The uterus should be treated before insemination if it is suspected to be diseased.

**Indicators of infertility**

Fertility problems are manifested through the very long calving intervals as a result of a prolonged service period. Some of the conditions that may indicate a fertility problem include:

i. Abnormal oestrus: Absence of heat, irregular heat, silent heat, constant heat (nymphomania)
ii. Embryonic or foetal death: Abortions, mummified foetus (foetus dying in uterus and becoming mummified)
iii. Outbreak of reproductive diseases e.g. brucellosis or trichomoniasis

**Fertility indices**

To gauge whether the farm is successful in fertility management of the herd, the following indices can be used.

a) Calving interval:

An efficient breeding program influences the productivity of a cow in that it determines the number of calves born and the total milk produced throughout its lifetime. A good indicator of successful breeding is a calving interval of one year.

b) Conception rate (number of animals conceiving as percent of number served)

70% after 1st service

80% after 2nd service

>90% after 3rd service

Animals not conceiving after 3 inseminations should be culled if all the factors in the fertility chain have been considered.

c) Desired herd composition

| | |
|---|---|
| Cows in milk | 45% |
| Dry cows | 9% |
| Pregnant heifers | 8% |
| Heifers (weaning to first service) | 14% |
| Heifers (birth to weaning) | 24% |

**Estrus synchronization**

Sometimes for ease of management, it is desirable for a group of animals to calve at the same time necessitating that animals come on heat at the same time. To achieve this, the animals are synchronised using hormones.

Synchronization is dependent on manipulation of hormonal events occurring during normal oestrous cycle. It is achieved via premature leuteolysis using prostaglandins (PG) or simulation of corpus leuteum (CL) function by administering progesterone followed by abrupt withdrawal.

**Embryo transfer**

This is a process through which an embryo is harvested from one cow and transferred to another cow to complete the pregnancy.

The process involves super-ovulation of the donor genetically superior cow (cow injected with hormone to stimulate development of many eggs), insemination of cow with high quality semen, synchronization of oestrous cycle of donor and recipient cows, flushing out the embryos from donor cow and transfer of embryo to recipient cow.

**Gestation period (**from successful conception to calving (280 ±10days))

During early pregnancy the foetal growth is slow and accelerates towards the end. Regeneration of mammary glands occurs towards the end of gestation in preparation of lactation.

During the first two months of gestation, growth of embryo is minimal but during the last three months there is marked growth of foetus which is dependent on nutritional level of dam, breed of animal and health of dam.

Therefore, during the last few weeks of pregnancy, cows should be fed enough to cater for the rapid growth of foetus and build up body reserves in readiness for the next lactation. This feeding is referred to as 'steaming' and coincides with the dry period (refer to feeding during dry period).

**Lactation period: (**calving to when the cow is dried: 305 days)

This period is variable due to variation in the service period but should be approximately 305days. Milk production peaks at around the 8th week depending on the feeding regime. Cows that are not well fed do not peak.

Management during this period should aim at getting as much milk from the cow as she can produce and as hygienically as possible for human consumption.

**Factors affecting milk production**

Milk production is not constant but varies from farm to farm and animal to animal. This variation allows for the manipulation to improve milk yield.

**Animal factors:**

Breed – Capacity for milk production decreases as follows - Friesian, Ayrshire, Guernsey, Jersey, Sahiwal, Boran and Zebu. This is attributable to the genetic makeup of the animal.

Parity (age)- Mature cows (>6 yrs) produce 25% more milk than young cows. First lactation yields 25% less than 4th lactation. After peak yield there is a decline, as cow

grows old. As milk yield increases with age, the herd should have both young animals (for genetic improvement) and old cows for higher milk production.

Stage of lactation- Milk production increases during the first two months following calving (peak production), then declines gradually thereafter.

Oestrus -Milk production drops the day the cow is on heat or day following heat.

Pregnancy- By the $4^{th}$ to $5^{th}$ month of pregnancy, total milk production of gestating cows declines faster than that of non- pregnant cows.

Size- Bigger cows will produce more milk than smaller cows of similar breed.

**Environmental factors:**

Feed – Nutrition is the most important determinant and a deficiency of nutrients, especially protein or energy will lower milk yield.

Length of dry period - A short dry period (<60d) usually results in lower milk production.

Condition of cow at calving - Excessively thin or fat cows produce less milk.

Frequency of milking - Cows milked 3 times produce 10-25% more milk than those milked twice. Cows milked 4 times produced 5-15% more milk than those milked thrice. Though there is increased milk yield with more than twice a day milking, there is extra labour and materials which has to be considered. More than twice a day milking is only recommended if economical (the extra milk pays for the extra cost of milking), for high yielding cows and for mastitis cases.

Farm layout - The relationship of watering points, pasture paddocks and the milking parlour is important. Animals walking long distances will utilize a lot of energy, which should go to milk synthesis.

Disease- Diseases like mastitis, ketosis, milk fever and others affect milk production.

Change of milker and milking routine will lower milk yield.

Climate -high temperatures reduce milk yield more drastically than low temperatures (affect animal comfort and feed intake). Exotic breeds are affected more affected by temperature than local breeds.

**Dry period (drying to calving: 60days)**

The dry period should last for about 60 days irrespective of whether the cow is still producing a lot of milk. Attempts should be made to minimize stress to the cow during the drying especially for high yielders.

Ways of drying cows:

- The feed intake should be reduce to maintenance level by withdrawing the concentrate and for high yielder, feed on low quality forages (eg straw) to reduce milk synthesis.
- For low yielding cows, just stop milking. Pressure builds up in udder and milk production is cut off.
- If cow is a high yielder, practice intermittent milking i.e. skip some milking times (milk only in mornings) so as to reduce milk synthesis due to pressure build up in udder while reducing feed intake.
- Water can be temporarily withdrawn for very high yielders to reduce milk synthesis.
- After cessation of milking, treat (infuse) all the quarters with long acting antibiotics to prevent development of mastitis.

**Reasons of drying**

There are several reasons that necessitate the drying the of cow:

i. Build up body reserves to meet next production - if a cow is not dried in time, it affects the milk production during the next lactation.
ii. Allow animal to regenerate alveolar tissue (milk synthesizing tissue) which might have atrophied during the lactation period.
iii. Save nutrients for the fast growing foetus. During the last phase of pregnancy, the calf grows at a fast rate and drying saves nutrients for its growth.

**Steaming up**

Steaming up of the cows is commencement to feeding extra ration, especially of concentrates, to late pregnant cows in an attempt to promote maximum milk production from the very beginning of the next lactation.

Some of the advantages of steaming up is provision of the extra nutrient required for the accelerated foetal growth, under regeneration and for cow to improve its body condition.

# CHAPTER 5: CLEAN MILK PRODUCTION

## Milk

Milk contains approximately 86% water, 4.7% sugar (lactose), 4.1% fat, 4.2% protein and 1% minerals. It supports the growth of micro-organisms and thus is prone to contamination.

The purpose of milking a dairy cow is to obtain milk that is fit for human consumption. Milk from the udder of a healthy cow contains very few bacteria and to ensure that it remains fresh for long it should be handled under conditions of good hygiene.

Unclean milk can be a source of disease to the consumer, rejected at the market and so is a loss to the farmer, does not keep for long and is not good for processing.

## Milking

The milking procedure is the first step in obtaining clean milk. At the farm this starts with ensuring the cow to be milked is healthy.

## The cow

The cow should be well fed with a diet well balanced with forage and concentrates to ensure high production of good quality milk. Feeding very high amounts of concentrates and low amounts of forages results in milk with low butter fat. On the other hand feeding too little concentrates leads to low milk yield.

An unhealthy cow will feed less and produce less milk. Cows should always be kept healthy and clean as sick animals can transmit diseases like tuberculosis and brucellosis to milk consumers. If a cow is suspected to be sick, a qualified veterinary practitioner should be contacted immediately. Milk from a cow that is being treated with antibiotics should not be consumed or sold until the withdrawal period is over.

Farmers are encouraged to vaccinate their animals against brucellosis. Animals should also be checked periodically for all types of contagious diseases and treated promptly in case they are infected.

Mastitis is an inflammation of the mammary glands in the udder caused by infection with disease-causing bacteria which can be controlled by observing general hygiene and proper milking procedure.

## The milker

Should:

- be healthy and clean
- Maintain short nails and hair (for ladies, cover the head when milking)

- Never smoke during milking time
- Milk quickly and completely without interruptions

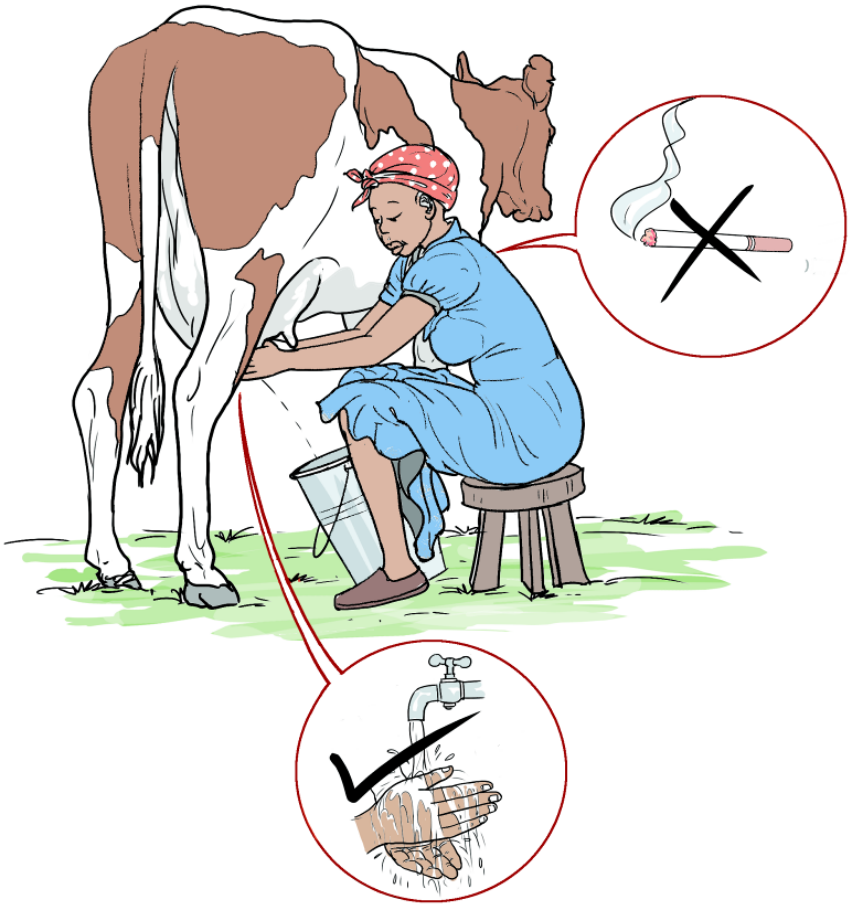


**Fig. 22: The do's and don'ts of hand milking a dairy cow**

## The environment

- A milking shed (parlor) which can be permanent or movable should be constructed. It should be located away from any smells.
- The floor of shed should be clean and dry and if possible have a cement floor for ease of cleaning.
- The shed should be cleaned after every milking and animals kept off outside milking time.

### Equipment

- Use seamless aluminum or stainless steel cans for milking and storing milk. Plastic container is difficult to clean.
- Clean utensils immediately after milking or after emptying milk: rinse with cold water, scrub with a brush using hot water with detergent then rinse with cold water. Place upside down on a rack and dry in the sun.
- Store utensils in a safe, clean and well ventilated room.

**Fig. 23: Milk cans**

## Milking

Milking is the most important activity in a dairy farm. Milk can be extracted either by hand or by machine. Hand milking is an art, which is improved with practice.

Alveolar cells synthesize milk, which is stored in the gland cistern. The sphincter muscle at the tip of the teat (teat sphincter) control milk let down. For efficient milking, teat should be of moderate size, symmetrical and enough tension of the sphincter muscle.

### Practical aspects of milking:

Milk synthesis and secretion is continuous unless interfered with by pressure from the filling of the gland cistern (this explains why more milk is extracted by frequent emptying (milking) to ensure pressure does not built up). The ejection of milk from alveolar lumen is under influence of oxytocin (hormone).

### Steps:

The cow is brought to the milking parlour as calmly as possible. Frightening the animal at this stage has a negative effect on milk let down due to release of adrenaline (hormone) which has a negative effect on milk letdown.

1. Feed the cow it's production ration (this is optional depending on the feeding system) - This calms the animal and stimulates milk letdown.
2. Restrain animal - tie hind legs above hock joint in the form of a figure 8. A loose knot should be used to safeguard both animal and man (applicable only for hand milking).
3. Wash hands with soap and clean water before milking. Dry hands with towel.
4. Test for mastitis using a strip cup - strip first few rays of milk into strip cup from each quarter and observe for any abnormalities. If mastitis is detected, the cow should be milked last.

**Fig. 24: Using a strip cup**

5. Wash udder with warm clean water with disinfectant using a clean towel. Warm water also stimulates milk let down. Dry udder using a dry towel.

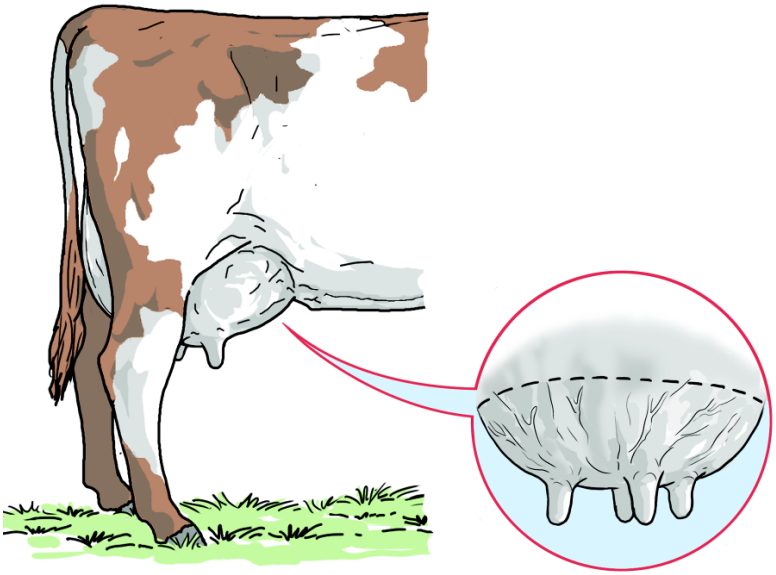


**Fig. 25: Area of udder to be cleaned**

6. Apply milking jelly - prevents cracking of teats and eases milking (for hand milking only)
7. Milk quickly and completely by squeezing the teat, do not pull. Milking each cow should take 7–10 minutes at most.
8. Use clean containers for milking.
9. After milking: Strip the animal - getting last drops of milk from udder to avoid incomplete milking (can lead to mastitis).
10. After milking dip the teats in a teat dip (disinfectant to ensure that bacteria do not gain entry through the teat sphincter which is loose immediately after milking).

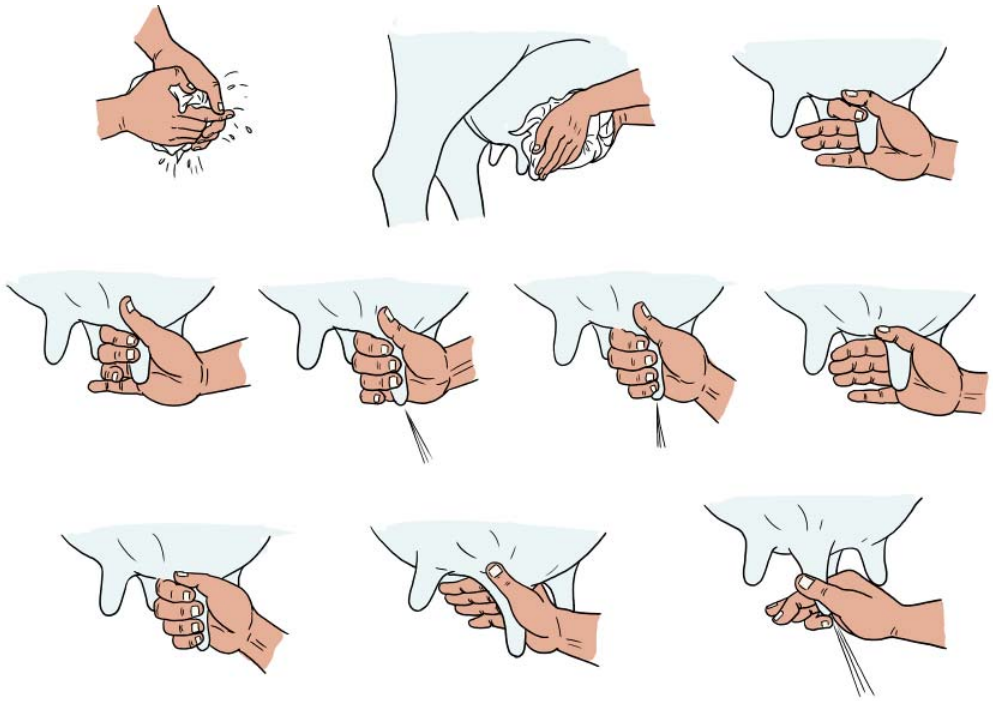


**Fig. 26: Step by step method of hand milking**

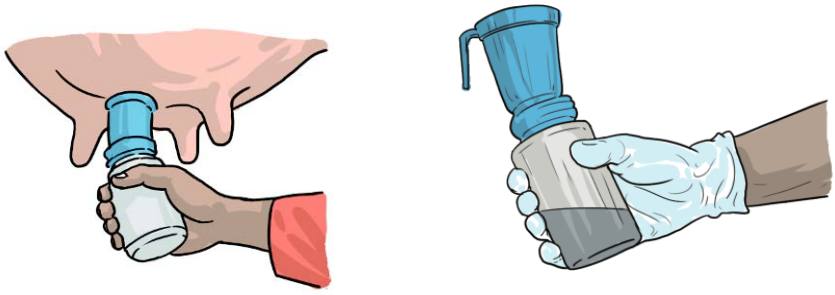


**Fig. 27: Dipping cow teats in disinfectant**

It is recommended that the animal remain in a standing position for at least one hour to ensure the teat does not come into contact with the ground while the sphincter is still loose.

**Note:**

- Routine milking procedures stimulate milk letdown and should therefore **not be changed** unnecessarily.
- After cow has been maximally stimulated for milk let down, it should be milked immediately since the stimulus reduces over time. Oxytocin effects are maximum between **5-10 minutes**, thus milking should be completed during this time.
- Don't harass animal since adrenaline (hormone produced due to fright) has opposite effect of oxytocin (milk let down hormone).

### Handling the milk

The following guidelines should be followed to avoid milk spoilage:

- Filter milk immediately after milking: Use a white filter cloth or strainer. Disinfect, wash and dry the cloth/strainer after use
- Always handle milk in clean, preferably metal, containers.
- When transferring milk between containers, pour the milk instead of scooping since scooping may introduce spoilage bacteria.
- Do not store milk at high temperatures.
- Do not handle milk if you are sick. Seek medical treatment and resume work only when the doctor says you are fit to do so
- Store milk in a cool clean place preferably lockable room set aside for milk only. If storing overnight, keep the milk in cold/ chilled water.
- Deliver milk to the market as soon as possible preferably in the cool morning or evening.

### Milk Storage

Store the milk without chemicals in a lockable cool and clean place.Do not mix warm (morning) milk with cool (evening) milk; deliver to the collection centre separately or cool the warm milk before mixing.

### Milk Preservation

Milk is highly perishable hence it should be preserved to ensure it is safe for human consumption at the home and that it reaches the processor and/or final consumer in good condition. The success of any preservation method is highly dependent on hygiene conditions under which the milk was produced. Hence milk produced from a healthy cow, milked by a healthy milker using clean equipment will be clean and more likely to keep long. Milk can be preserved using the following simple methods:

### Cooling

Cooling milk slows down the growth and activity of germs and hence prevents spoilage. Milk can be cooled through:

- Keeping under a shade
- Dipping the containers with milk in a cold water bath, flowing stream of cooling tank
- Keeping the milk in a refrigerator
- Using a charcoal cooler
- Using cooling rings: if cool (10°C or less) running water is available, you can pass it through a perforated ring so that it flows over the cans
- Using an electrical cooling tank.

When cooling milk, loosen the lids of the cans to allow the air to escape, and make sure no water gets into the milk. Cover the cooling tank with a lid to protect the milk from insects and dust.

### Heating

Heating kills many bacteria and heated milk will keep longer. It also gets rid of harmful micro-organisms that could transfer diseases from the cow to humans. The best method of heating milk (to retain the taste and avoiding off-flavours) is to immerse the milk can in boiling water for at least 30 minutes.

Milk to be consumed at home should be boiled, using a large pan or other cooking container. Milk can be heated to a certain temperature and kept at that temperature for some time to kill germs, then cooled. This is called pasteurisation. A thermometer is required for monitoring the temperatures. Milk can also be subjected to low heat treatment. Heat the milk to 65°C then cool.

### Chemicals

Chemicals can be used to preserve milk but only on advice from the collecting centre because it is important to use the correct types and amounts. Use of chemicals is illegal in some countries and only milk delivered to a dairy plant should be preserved with chemicals. Nevertheless, chemicals allow un-cooled milk to keep longer even in high temperatures and, if used correctly, chemicals have little effect on the physical quality of the milk.

### Proper cleaning of milk equipment

### Milk cans

Immediately cans are emptied of milk they should be cleaned as follows:

- Rinse with cold water.
- Scrubbing with brush and warm detergent (any un-perfumed liquid soap will do).
- Rinse with cold water.
- Sterilize (sanitise) with boiling water or steam if available or use dairy sanitising solution such hypochlorite or commercial brand preparations in accordance with manufacturer's instructions.
- Dry cans on a drying rack. Exposure to sunlight will enhance killing off bacteria during drip drying of cans.

### Milking machines

Milking machines should be cleaned according to recommended practice:

- Rinse with cold water.
- Use the "cleaning-in-place" (CIP) method where detergent in hot water is circulated in the system.

- Rinse with hot water.

Timely replacement of worn out rubber parts should be undertaken regularly.

**Cleaning and sanitation of milk transportation equipment**

Transport of larger quantities of milk requires insulated bulk tankers. These are very expensive and require special additional equipment like pumps which should also be thoroughly cleaned by the “cleaning-in-place” (CIP) method.

Milk transportation equipment should be properly cleaned and sanitised because milk provides an ideal medium for growth of bacteria. Select detergents and sanitizers that will not corrode the material from which the equipment is made. Cleaning and sanitizing are complementary processes.

**Maintenance of milk handling and cooling equipment**

**Maintenance of milk coolers**

For best use of milk cooling equipment, it is important to adhere to the following:

- Avoid opening the milk cooler unnecessarily to prevent warm air from entering
- Ensure that the evaporator is well ventilated for proper function of cooler
- Ensure that the cooler always has enough refrigerant in the system.
- Connect the cooler to a voltage stabiliser to provide for a constant supply of electricity.
- Set up schedules for cleaning and preventive maintenance and ensure that they are followed. Any mechanical repairs should be carried out by a trained technician.
- Have a standby generator in case of power failure.

**Characteristics and maintenance of bulk tanks**

Milk cans should be maintained by proper handling and adherence to regular cleaning and sanitation schedules. Cleaning, sanitizing and rinsing of bulk tankers and accessories like pumps should be done immediately after emptying the milk. The valves, hose connections and lid of the tanker should be covered to prevent the milk from being contaminated with dirt.

**Importance of carrier maintenance**

Milk transport vehicles often get dented during loading and offloading. Milk cans are designed with rims at the bottom to resist deformation during rough handling. Milk should be transported as quickly as possible to the milk cooling centre or processing factory to avoid spoilage. But milk that already has many bacteria will not keep for long, even when cooled.

For small scale dairy farmers, setting up a milk cooling centre centrally may be the ideal solution. Where farmers bring their milk to a cooling centre through a cooperative, they should do so as soon as milking is completed.

A Milk cooling centre with a capacity of 1000 - 3000 litres will serve up to 300 small holder farmers ensuring that the quality of their milk when produced under hygienic conditions is well preserved and accepted at the processing plant.

It is important to remember that under a hot environment milk will spoil within 3-4 hours. So any means of cooling that will lower the temperature of milk from $38^0$C at milking will help to prevent multiplication of bacteria. There are several options available.

In highland areas such as Kinangop, Limuru, Timboroa where the water temperature can be as low as $10^o$C, the milk may be cooled down to $20^o$C using water temperature through immersing milk cans in a water trough connected to a water tap or water spring.

**Surface milk cooler**

In hot areas like in the coast, Western Province, North Eastern, Nyanza, cooling of milk to 3-$5^0$C below ambient temperature may be achieved through use of charcoal lined evaporative cooling cabinet.

**Milk transport to processing factory**

Bulk milk transport

Milk cooled on the farm or cooling centre may be transported in milk cans or in bulk tankers. Bulk tankers are insulated, so the milk will remain cold until it reaches the plant. This is dependent on transport being fast, i.e. short distance or good roads enabling milk to be delivered before the temperature of milk rises above $10^0$C.

Alternatively, such milk may be filled in cans and transported in milk cans. This has advantageous in case of a farmer's delivering a can of POOR quality milk, it does not get mixed with other farmers' GOOD quality milk and spoil the lot. Since the cans are not insulated, the transport to the factory must be efficient enough to enable milk reach the factory in acceptable condition.

In the case of farmers delivering milk to a collection point it is advisable that the milk cans are placed in a shaded area while awaiting pick-up by a milk transport vehicle.

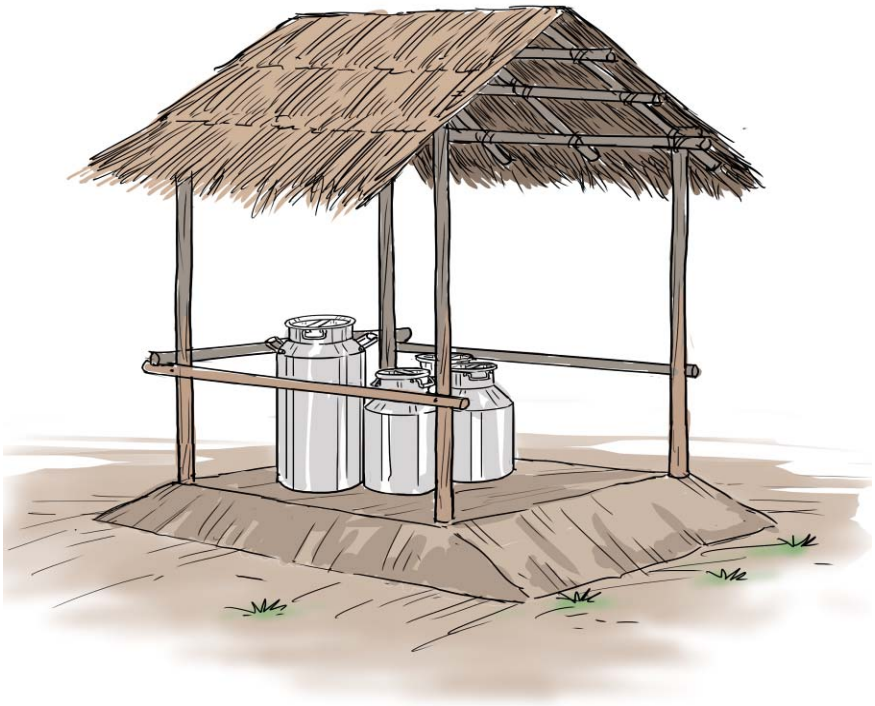


**Fig. 28: Provision of shade at pick up points is important**

Bad milk will be rejected at the dairy plant resulting in the farmer losing money. The milk transporter may lose money if the spoilage was due their fault. The nation will suffer because its people will not have the high quality food. To avoid all these bad things happening, hygienic milk handling is essential at each stage; at the **farm, cooling centre** and **during transport.**

## BASIC MILK QUALITY TESTS

There are four simple milk quality tests that may be carried out routinely both at the farm and milk collection centre:

- Sight-and-smell (organoleptic) test
- Clot-on-boiling test
- Alcohol test
- Lactometer test

These tests ensure that only milk of acceptable quality is received and require only a small amount (sample) of milk from each container. If the sample of milk doesn't pass the test, the milk from that container will be rejected and in most cases, the farmer bears the loss. Thus, it is important that milk is handled in accordance with good hygienic practice particularly at the farm. The procedures of these milk quality tests are described below:

### Organoleptic test

This should be the first test to be performed and it involves assessing the milk with

regard to its smell, appearance and colour. This test is quick and cheap to carry out, allowing for segregation of poor quality milk. No equipment is required, but the tester should have a good sense of sight and smell. Milk that cannot be adequately judged in this way is subjected to tests that are more objective.

**Procedure**

- Open a can of milk.
- Immediately smell the milk and establish the nature and intensity of smell, if any. The milk will not be accepted if it smells slightly sour or has foreign odours like paint or paraffin.
- Observe the colour of milk. Deviation from the normal yellowish-white colour indicates damage to the udder (reddish—blood, or yellow—pus).
- Check for any foreign bodies or physical dirt, which may indicate that the milking and handling were not done hygienically.
- Touch the milk container to feel whether it is warm or cold. This indicates how long the milk has taken since milking (if not chilled thereafter) and will influence the lactometer test for adulteration (see below).

Abnormal appearance and smell that may cause milk to be rejected could be due to:

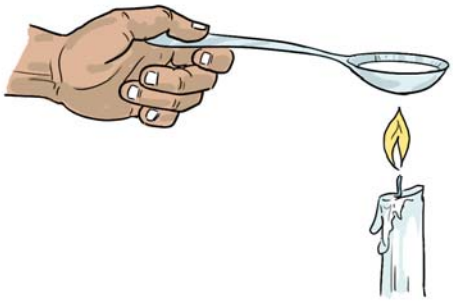
- Type of feed or atmospheric taint (e.g. feeding silage or brewer's waste too close to milking time)
- Cows in late lactation or in some cows when on heat or soon after conception (due to hormonal changes)
- Bacterial taints (from cows with mastitis)
- Chemical taints or discolouring (may be due to equipment not rinsed properly)
- Advanced acidification or souring (milk that is fermenting)
- Marked separation of fat may be caused by:
- Milk previously chilled and subjected to excessive shaking during transportation
- Adulteration with other solids (may also show as sediments or particles)
- Boiling, if milk fat is hardened

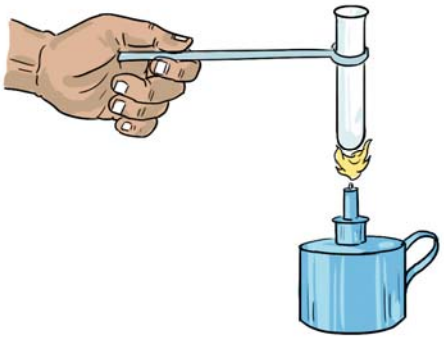
**Clot-on-boiling test**

This test is quick and simple. It allows for detection of milk that has been kept for too long without cooling and has developed high acidity, or milk that has a very high percentage of colostrum and hence protein. Such milk does not withstand heat treatment hence this test could be positive at a much lower acidity.

**Procedure**

- Boil a small amount of milk for a few seconds in a spoon or other suitable container.
- Observe immediately for clotting.
- The milk will be rejected if there is visible clotting, coagulation or precipitation.



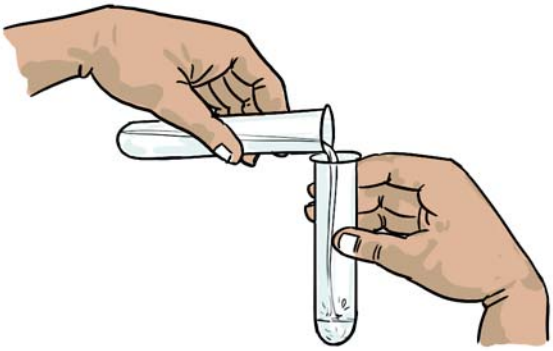


**Alcohol test**

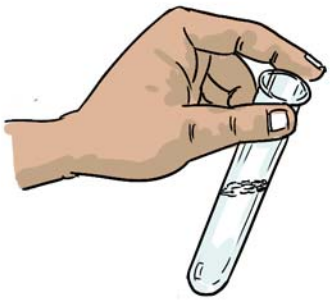
The test is quick and simple. The specific type of alcohol used is known as “ethanol”. This test is more sensitive to lower levels of acidity and can therefore detect bad milk that may have passed the previous two tests. It also detects milk that has kept for long without cooling, colostrum or milk from a cow with mastitis. Because this test is quite sensitive, milk that passes this test can keep for some hours (at least two hours) before it goes bad.

**Procedure**

- Use a syringe to draw equal amounts of milk and 70% alcohol solution into
- a small tube or glass cup (such as those used to administer medicine to children).
- Mix 2 ml milk with 2 ml 70% alcohol and observe for clotting or coagulation.
- If the tested milk sample coagulates, clots or precipitates, the milk will be rejected.



Mix 2 ml of milk with 2 ml of 70% alcohol



If the milk coagulates, it fails the test

**Lactometer test**

This test is used to determine if the milk has been adulterated with water or solids. Addition of anything to milk can introduce bacteria that will make it spoil quickly, is dishonest and is therefore illegal. The lactometer test is based on the fact that milk has a heavier weight or density (1.026–1.032 g/ml) compared to water (1.000 g/ml). When water or other solids are added to milk, the density either decreases (if water is added) or increases (if solids are added). If milk fat (cream) is added to milk, the density decreases. The equipment used to measure milk density is called a lactometer. Most lactometers are usually marked from “0” (representing density of 1.000 g/ml) to “40” (representing density of 1.040 g/ml).

**Procedure**

- Leave the milk to cool at room temperature for at least 30 minutes and ensure its temperature is about 20°C.
- Stir the milk sample and pour it gently into a 200 ml measuring cylinder or any container deeper than the length of the lactometer.
- Let the lactometer sink slowly into the milk.
- Take the lactometer reading just above the surface of the milk.

If the temperature of the milk is different from the lactometer calibration temperature (20°C), then use this correction factor:

- For each °C above the calibration temperature, add 0.2 lactometer “degrees” (°L) to the observed lactometer reading.
- For each °C below calibration temperature, subtract 0.2 lactometer “degrees” (°L) from the observed lactometer reading.
- Note: These calculations are done on the lactometer readings (e.g. 29 instead of the true density of 1.029 g/ml).

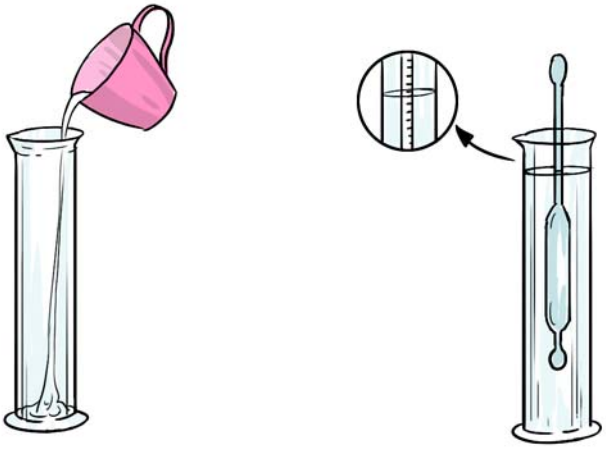


**Table 9. Examples of how to calculate the true lactometer readings when the milk temperature differs from the calibration temperature of 20°C**

| Milk temperature °C | Observed lactometer reading °L | Correction °L | True lactometer reading °L | True density g/ml |
|---|---|---|---|---|
| 17 | 30.6 | - 0.6 | 30.0 | 1.030 |
| 20 | 30.0 | nil | 30.0 | 1.030 |
| 23 | 29.4 | + 0.6 | 30.0 | 1.030 |

If the milk is normal, its lactometer reading will be between **26 and 32**. If the lactometer reading is below 26 or above 32, the milk will be rejected because it means that it has been adulterated with added water or solids.

# CHAPTER 6: DAIRY CATTLE HOUSING

## General Housing Requirements

Dairy cattle will be more efficient in the production of milk and in reproduction if they are protected from extreme heat, and particularly from direct sunshine. This can be achieved through provision of shade in tropical and subtropical climates. If dairy cattle are confined, the area should be free of mud and manure in order to reduce hoof infection to a minimum. Concrete floors or pavements are ideal where the area per cow is limited. However, where ample space is available, an earth yard, properly sloped for good drainage is adequate.

## Zero Grazing

Majority of dairy animals are kept by smallholder farmers under zero grazing or semi zero grazing systems. Below is a layout of a zero grazing unit five cows.

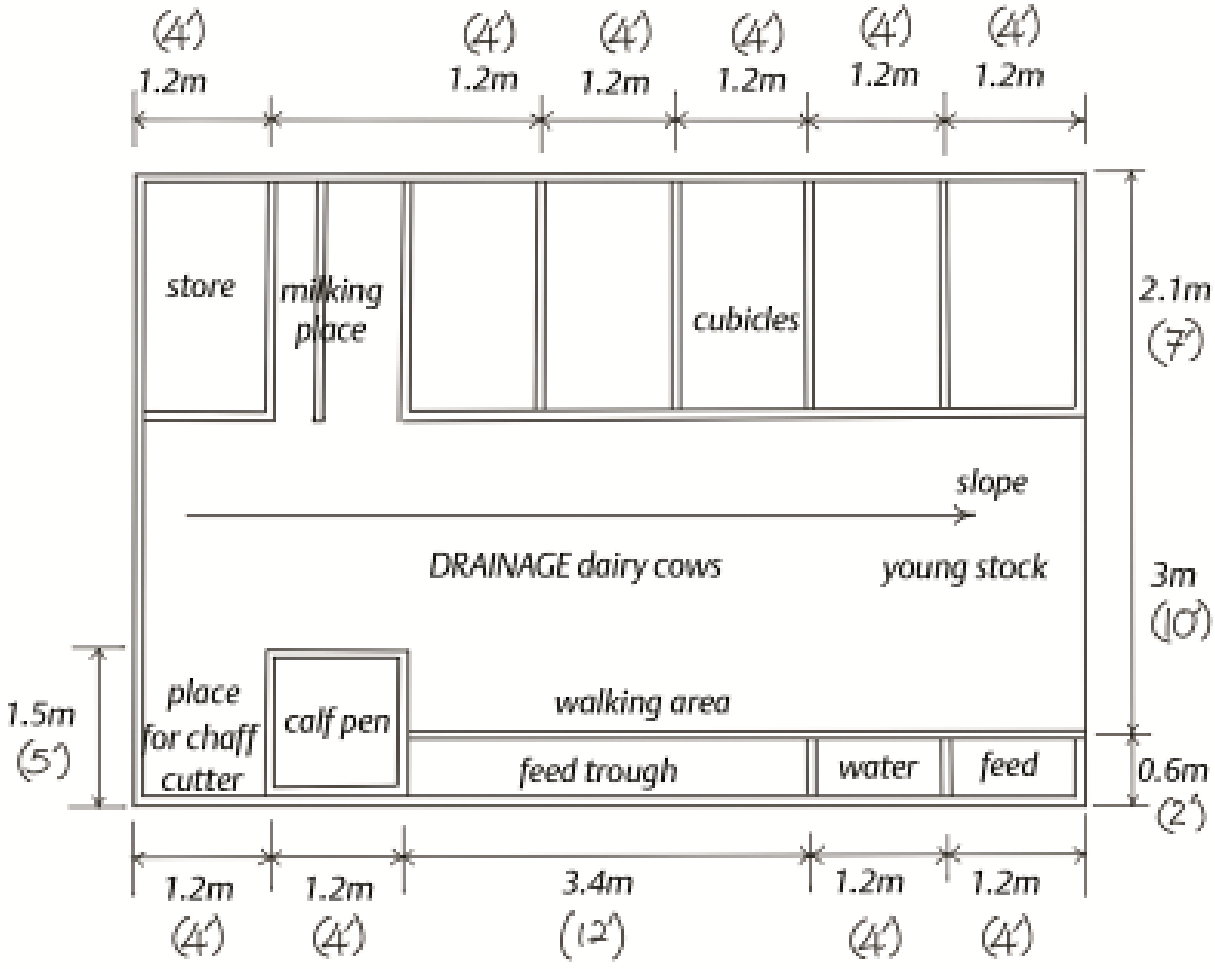



**Fig. 29: Layout of a zero grazing unit for 5 cows**

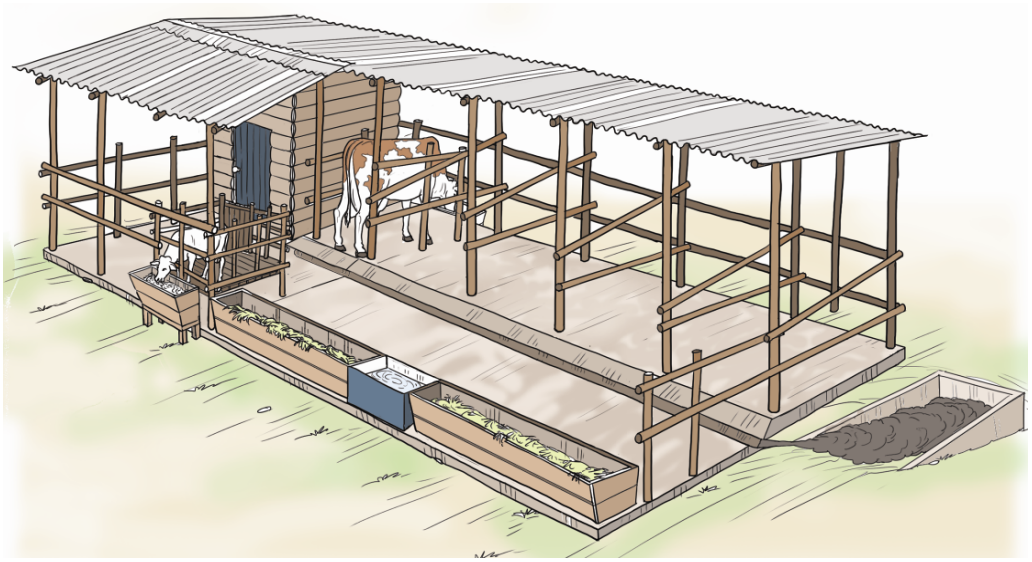


**Fig. 30: A zero grazing unit complete with a sun shade structure**

## Sun Shade

When constructing a shade structure, it should allow 2.5 to 3m per animal which will give the minimum desirable protection for cattle, whether it be for one animal belonging to a small holder or many animals in a commercial herd. The roof should be a minimum of 3m high to allow air movement. If financially feasible, all the area that will be shaded some time during the day should be paved with good quality concrete.

The size of this paved area depends on the orientation of the shade structure. If the longitudinal axis is east and west, part of the floor under the roof will be in shade all day. Extending the floor approximately one third its length on the east and on the west, a paved surface will provide for the shaded area at all times.

If the longitudinal axis is north and south, the paved area must be 3 times the roof area i.e. 1/3 to the east, 1/3 to the west and l/3 underneath.

In deciding which orientation to build, the following factors need be considered:

1. With the east-west orientation the feed and water troughs can be under the shade which will allow the cows to eat and drink in shade at any time of the day. The shaded area, however, should be increased to 3 to 4m² per cow. By locating the feed and water in the shade, feed consumption will be encouraged, but also more manure will be dropped in the shaded area which in turn will lead to dirty cows.
2. With the north-south orientation, the sun will strike every part of the floor area under and on either side of the roof at some time during the day. This will help to keep the floored area dry. A shaded area of 2.5 to 3m² per cow is adequate if feed and water troughs are placed away from the shaded area.

3. If it is felt that paving is too costly, the north-south orientation is the best choice in order to keep the area as dry as possible.
4. In regions where temperatures average 30°C or more for up to five hours per day during some period of the year, the east-west orientation is most beneficial.

The gable roof is more wind resistant than a single pitch roof and allows for a centre vent. A woven mat of local materials can be installed between the rafters and the corrugated iron roof to reduce radiation from the steel and lower temperatures just under the roof by 10°C or more.

**Deep-Bedded Sheds**

In a deep-bedded system, straw, sawdust, shavings or other bedding material is periodically placed in the resting area so that a mixture of bedding and manure builds up in a thick layer. Although this increases the bulk of manure, it may be easier to handle than wet manure alone. This system is most practical when bedding is plentiful and cheap. By designing the building to be partially enclosed on the east and west, the shading characteristics can be improved. In as much as a well drained earth floor is quite adequate, such a building will compare favourably in cost with a shaded area which is paved.

**Loose Housing with Free Stalls**

Although simple yard and a shade or yard and bedded shed systems are entirely satisfactory in warm climates, particularly in semi-arid areas, some farmers may prefer a system with somewhat more protection. A loose housing yard and shed with free stalls will satisfy this need. Less bedding will be required and less manure will have to be removed.

Free stalls must be of the right size in order to keep the animals clean and to reduce injuries to a minimum. When stalls are too small, injuries to teats will increase and the cows may also tend to lie in other areas that are less clean than the stalls. If the stalls are too large, cows will get dirty from manure dropped in the stall and more labour will be expended in cleaning the shed area. A bar placed across the top of the free stalls will prevent the cow from moving too far forward in the stall for comfortable lying down movements, and it will encourage her to take a step backwards when standing so that manure is dropped outside the stall.

The bar must, however, not interfere with her normal lying and rising movements. The floor of the stall must be of a non-slippery material, such as soil. A good foothold is essential during rising and lying down movements to avoid injury. A

100mm ledge at the back edge of the free stall will prevent any bedding from being pulled out to the alley. The number of stalls should ordinarily correspond with the number of animals housed, except that in large herds (80 or more), only about 90% of the animals need to be accommodated at one time. Young stock may be held in yards with shade or in sheds with either free stalls or deep bedding.

The alley behind the free stalls (cubicles) must be wide enough to allow the cows smooth passage and the following minimum widths apply:

**Table 10. Area for bedded sheds and dimensions of free stalls (cubicles)**

| Animal | Age Months | Weight kg | Bedded Shed Area per Animal (m²) | | Free Stalls Dimensions (m) | |
|---|---|---|---|---|---|---|
| | | | A | B | Length | Width |
| Young stock | 1.5 - 3 | 70 - 100 | 1.5 | 1.4 | 1.2 | 0.6 |
| Young stock | 3 - 6 | 100- 175 | 2.0 | 1.8 | 1.5 | 0.7 |
| Young stock | 6 - 12 | 175 - 250 | 2.5 | 2.1 | 1.8 | 0.8 |
| Young stock | 12 - 18 | 250 - 350 | 3.0 | 2.3 | 1.9 | 0.9 |
| Bred heifers and small milking cows | | 400 - 500 | 3.5 | 2.5 | 2.1 | 1. 1 |
| Milking cows | | 500 - 600 | 4.0 | 3.0 | 2.2 | 1.2 |
| Large milking cows | | > 600 | 5.0 | 3.5 | 2.3 | 1.2 |

*A -Enclosed and fully covered bedded shed B - Bedded shed in conjunction with exercise yard*

The tie and feed barrier construction must allow the cow free head movements while lying down as well as standing up, but should prevent her from stepping forward into the feed trough. Most types of yokes restrict the cow's movements too much. A single neck nail, set about 1 m high and 0.2m in over the merger may bruise the cow's neck when she pushes forward to reach the feed.

### Bull Pens

A bull pen should have a shaded resting area of 12 to 15m² and a large exercise area of 20 to 30m². The walls of the pen must be strong. Eight horizontal rails of minimum 100mm round timber or 50mm galvanised steel tubes to a total height of 1.5m and fixed to 200mm timber posts not more than 2m apart will be sufficient. The gate must be designed so that the bull cannot lift it off its hinges and there should be at least two exits where the herdsman can escape.

A service stall where the cow can be tethered prior to and during service is usually provided close to the bull pen.

**Alleyways**

It is desirable to pave the alley, but if that is not possible, the distance between the free stalls (cubicles) and the feed trough should be doubled or tripled.

A concrete pit or sloping slab in which to accumulate manure is essential. If the alley is paved, the pit can also collect urine. In fact, paving the alley not only saves space, but the value of the urine will help to pay for the paving.

The circular manure tank a volume of $10m^3$ will be adequate to store the manure produced during one month plus any rainfall collected in the alley. If more stalls are added the capacity of the tank will need to be increased or the interval between the emptying shortened.

**Water Catchment**

A water tank to collect water from the roof can be very useful unless there is an abundant supply of water nearby.

**Housing for the Medium to Large Scale Herds**

For the farmer with up to 30 cows a yard with paved shade and feed area would be suitable. The yard and feeding area may alternatively be combined with an open sided barn designed for deep bedding or equipped with free stalls and where the herd consists of high yielding cows the milking shed may be equipped with a bucket milking machine. Some farmers with up to 30 cows may even consider using an open sided tie-stall shed.

In general a medium or large scale dairy unit may include the following facilities:

1. Resting area for cows:
    a) Paved shade, or
    b) Deep bedding in an open sided barn, or
    c) Free-stalls in an open sided barn
2. Exercise yard (paved or unpaved)
3. Paved feed area:
    a) Fence line feed trough (shaded or unshaded), or
    b) Self-feeding from a silage clamp
4. Milking Centre:
    a) Milking shed or parlour,
    b) Collecting yard (part of the exercise yard),

c) Dairy including milk store
d) Motor room

5. Calving pen(s)
6. Calf accommodation
7. Young stock accommodation (yard with paved shade and feed area)
8. Bulk feed store (hay and silage)
9. Concentrate feed store
10. Veterinary facilities:
    a) Diversion pen with Artificial Insemination stalls
    b) Isolation pen
11. Waste stores:
    a) Slurry storage, or
    b) Separate storage of solids and effluents
12. Office and staff facilities

Each of the parts of the dairy unit may be planned in many different ways to suit the production system and the chosen method of feeding. Some requirements and work routines to consider when the layout is planned are as follows:

a) Movement of cattle for feeding, milking and perhaps to pasture.
b) Movement of bulk feed from store to feeding area and concentrates from store to milking shed or parlour.
c) Transfer of milk from milking shed or parlour to dairy and then off the farm. Clean and dirty activities, such as milk handling and waste disposal, should be separated as far as possible.
d) The diversion pen with Artificial Insemination stalls and any bull pen should be close to the milking centre as any symptoms of heat or illness are commonly discovered during milking and cows are easily separated from the rest of the herd while leaving the milking.
e) Easy and periodical cleaning of accommodation, yards, milking facilities and dairy, and transfer of the waste to storage and then to the fields.
f) The movements of the herdsman. Minimum travel to move cows in or out of milking area.
g) Provision for future expansion of the various parts of the unit.

# CHAPTER 7: COMMON DISEASES

## Mastitis

Mastitis is an infection (inflammation) of the udder caused by microorganisms (bacteria) entering the quarter through the teat end. When the bacteria load becomes too high due to dirty environment or damaged teats (allowing invasion), infection may occur. Most of the mastitis cases (about 95%) are subclinical (show no signs) but result in lower milk production and higher cell count (an indicator of milk spoilage). When stress occurs, subclinical mastitis flares up and become clinical.

## Causes of Mastitis

Bacteria are by far the most common causes of mastitis. Chief pathogens include

- Streptococcus agalactiae
- Staphylococcus aureus

S. agalactiae is the most common cause of subclinical mastitis but rarely cause acute mastitis. The organism lives inside the cow's udder and survives only for a short time outside the mammary gland. It spreads primarily during milking via the milking machine, and contaminated hands and materials (cloths).

S. aureus lives inside and outside the udder on the teat skin. The microorganism can cause both clinical and sub-clinical mastitis and spreads the same way as S. agalactiae.

Infections caused by coliform bacteria are less common than other types, but can cause very severe cases of clinical mastitis. Coliform bacteria are abundant in wet bedding materials, manure and polluted water. Coliform mastitis occurs more frequently in herds which are relatively free of other types of mastitis infections, are housed in unsanitary conditions or milked while the udders are wet.

## Detection of Mastitis

Clinical signs: *Mild signs* include flakes or clots in the milk and may have slight swelling of infected quarter. *Severe signs* include secretion of abnormal milk: hot, swollen quarter or udder; cow may have a fever, loss of appetite, dehydration and death may occur.

Strip cup: The strip cup is an important in the milking parlor for determining the presence of clinical mastitis. The test is rapid and can easily be adapted as a part of

milking routine. Few streams of the foremilk are squirted onto the strip cup and are visually examined for milk abnormalities. The strip cup test should be conducted on every cow at every milking and milk from any cow found to have abnormal milk should be withhold from the supply.

California mastitis test: The California Mastitis Test (CMT) estimates the number somatic cells present in the milk.

**Prevention of Mastitis**

The goal of every mastitis control program is to prevent bacteria from entering a normal and healthy mammary gland. This means that each step involved in proper milking procedures must occur at each milking every day for each cow in the herd.

This can be achieved through several ways:

Proper milking hygiene: Bacteria are transmitted from infected to uninfected through hands of the milker. Thus the milers' hands should be washed thoroughly with disinfected soaps before milking and clinically infected cows should be milked last. Teats should be cleaned and dried before milking.

Milking machine: The machine should function properly by ensuring proper vacuum levels (minimal fluctuation) through proper maintenance of vacuum regulator.

Dipping the teats. Teat dipping reduces the rate of new infection substantially. Ensure use of suitable disinfectant.

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Dry cow therapy: Effective use of infused antibiotic into each quarter can reduce considerably the occurrence of mastitis in dry cows. This treatment is also very effective in clearing chronic and subclinical mastitis that are difficult to treat during lactation.

Culling of chronic cases: This clears the reservoirs.

Nutrition: Deficiencies of selenium and vitamin E in feed have been associated with increased cases if mastitis.

**Cost of Mastitis**

The greatest amount of money lost with mastitis is reduction in milk yield. Increased cost is also in from treatment, discarded milk and with chronic mastitis, premature culling. Acute cases of mastitis can result in loss of the animal through death.

**Milk Fever**

Milk fever is a common metabolic disorder in dairy cattle that generally affects older,

high producing cows. It may also be referred to as parturient paresis or hypocalcaemia.

At the beginning of lactation high yielding cows experience a sudden rise in demand for calcium to replace the large amount lost through milk. This may result in great decrease in blood calcium if the cow is not able to replenish the calcium fast enough, causing a disease called milk fever.

The majority of milk fever cases occur within 48 to 72 hours of calving when demand for calcium for milk production exceeds the body's ability to mobilize calcium reserves. Fever is a misnomer as body temperature is usually below normal. Low blood calcium interferes with muscle function throughout the body causing general weakness, loss of appetite and eventually heart failure.

**Signs of Milk Fever**

At first, cow experiences muscle tremors, lack of appetite, and unsteadiness. Eventually, cow is unable to rise, body temperature falls, and constipation occurs. Cows go down to a sitting position often with a kink in her neck. Death can occur if the cow is not treated promptly.

**Causes of Milk Fever**

The onset of milk production drains on the animal's blood calcium levels. If the cow is unable to replace this calcium quickly enough due to loss of its ability to mobilize reserves of calcium in bone and absorb calcium from the gastrointestinal tract, milk fever occurs. Older cows are more susceptible as they produce more milk and are unable to replenish calcium quickly.

**Prevention of Milk Fever**

Management of the diet can be a valuable aid in preventing milk fever. The key to prevention of milk fever is management of a close-up dry cow which should be kept on a low calcium diet. This stimulates their calcium regulatory system to keep the blood levels normal by mobilizing the body stores from the bone.

When the demand for calcium increases at calving, calcium can be mobilized much more rapidly thus preventing milk fever. Lucerne, a feed high in calcium and potassium, should not be a major ingredient in close-up dry cows' diets. In early lactation, high yielding cows should receive as much calcium as possible. High risk cows can be injected with Vitamin D3 2-8 days prior to calving.

Diets providing less than 15gcalcium/cow/day and fed for at least 10 days before calving will reduce the incidence of milk fever.

**Ketosis**

Ketosis, or acetonaemia, is a metabolic disorder in cattle associated with an inadequate supply of the nutrients necessary for the normal carbohydrate and fat metabolism that is seen mainly in times of high milk production in early lactation. During early lactation, the energy intake is insufficient to meet the energy output in milk and the animal is in a negative energy balance. Hypoglycemia (low blood sugar) is the major factor involved in the onset and development of clinical signs of ketosis. Ketosis affects high producing cows during the first 6-8 weeks of lactation when cows are in negative energy balance.

Ketosis occurs when energy intake fails to meet the requirements for high glucose production, necessary for mainte-nance and milk lactose production.

The excessive ketone bodies in the bloodstream come from the breakdown of fat when the animal is forced to draw on its bodily reserves for energy. Although the metabolism of body fat provides energy for cows, the nervous system is dependent on glucose, and the ketones produced as a result of excessive fat metabolism can have toxic effects. The excess ketone bodies are eliminated in the urine, milk and breath of the animal.

**Predisposing factors**

Cows of any age may be affected but the disease appears more common in later lactations peaking at about the 4th lactation. Over conditioning at calving has been associated with increased incidence of ketosis.

A reduction in the production of propionic acid, the main precursor of glucose in ruminants, will result in hypoglycaemia. Hypoglycaemia leads to a mobilization of free fatty acids and glycerol from the fat stores. The reduction of propionic acid production is usually the result of underfeeding or a reduced feed intake caused by in-appetence. The in-appetence may be caused by poor feed quality, sudden changes in diet or excessive fatness at calving.

**Clinical signs of Ketosis**

In many cases of ketosis, the disease is sub-clinical, with the cow’s performance and health compromised, but without obvious clinical signs. The clinical signs of ketosis include lack of appetite (refusal to eat even concentrates) and a sudden drop in milk output. There is a sweet smell of acetone in the urine, breath and milk.

Cows will have raised blood ketone levels and may excrete ketones in urine and milk. There is a gradual loss of body condition over several days or even weeks.

**Prevention of Ketosis**

Ketosis causes financial loss through lost production and treatment. It may be prevented by management strategies that maintain a good appetite and supply adequate feed to meet this appetite during the late dry period and immediately after calving. These strategies include;

i. Avoid sudden changes in feed type to newly calved animals
ii. Ensure cows in body condition 4.0 or less prior to calving.
iii. Ensure that any health problems that may cause reduced feed intake are treated as early as possible.

**Acidosis**

Acidosis is a syndrome related to a fermentative disorder of the rumen resulting in overproduction of acid resulting in lowering of rumen pH below pH 5.5. The problem is related to feeding management, where the ration has high levels digestible carbohydrates and low effective fiber.

Acidosis commonly occurs when switching from a high fiber to high concentrate diet (that is rich in fermentable carbohydrates (starches and sugars)). Large amounts of starch and sugar stimulate bacteria that make lactic acid. In a normal, healthy rumen, lactic acid production equals lactic acid use. Large amounts of starch and sugar stimulate bacteria that make lactic acid. In this instance, bacteria that normally use lactic acid cannot keep up with production.

Lactic acid is about ten times a stronger acid than the other rumen acids and causes the rumen pH to decrease. As the rumen pH drops below 6.0, bacteria that digest fiber begin to die depressing fiber digestion.

**Causes of Acidiosis**

i. Diets very high in readily fermentable carbohydrates and low in roughage
ii. Very fast switch from high forage to high concentrate.
iii. Excessive particle size reduction by feeding finely chopped forage

**Signs of Acidiosis**

Low milk fat test (one of the end products of fiber digestion (acetate) is a precursor of milk fat synthesis).

Diarrhea (Accumulation of acid causes an influx of water from the tissues into the gut resulting in diarrhea. The feces are foamy with gas bubbles. There is an appearance of mucin/fibrin casts in feces).

**Sore hooves-laminitis**

Endo-toxins resulting from high acid production in the rumen also affect blood capillaries in the hoof, causing them to constrict resulting in laminitis.

High levels of acid in the rumen also cause ulcers in the rumen resulting in infiltration of bacteria into the blood causing liver abscesses, which are seen at post mortem.

**Prevention Sore hooves-laminitis**

Good management practices are needed to prevent the predisposing situations from occurring. The root problem must be found and corrected.

Buffers can also be used to prevent drop in rumen pH when high concentrate diets are fed. Ensuring presence of effective fiber in the diet promotes production of saliva which is a buffer.

**Bloat**

Bloat is the abnormal accumulation of gas in the rumen. There are three categories of bloat:

i. Frothy bloat which occurs when diets that lead to the formation of a stable froth or foam in the rumen are fed.
ii. Free gas bloat caused by diets that lead to excessive gas production
iii. Free gas bloat caused by failure to eructate rumen gases leading to accumulation (e.g. esophageal obstruction).

When bloat occurs, gases cannot escape and they continue to build up causing severe distention of the abdomen, compression of the heart and lungs, and eventually death.

**Predisposing factors**

Bloat is a risk when animals are grazing young, lush pasture, particularly if the pasture has high legume content (clover or lucerne). Ruminant animals produce large volumes of gas during the normal process of digestion which is either belched or passes through the gastrointestinal tract. If anything interferes with the gas escape from the rumen, bloat occurs.

Natural foaming agents in legumes and some rapidly growing grasses cause a stable foam to form in the rumen. Gas is trapped in small bubbles in this foam in the rumen and the animal cannot belch up the gas. Pressure builds up in the rumen causing an obvious swelling on the left side of the body.

**Signs of Bloat**

i. Animal stops grazing and is reluctant to walk
ii. The left side of abdomen is distended
iii. The animal strains to urinate and defecate
iv. Rapid breathing — mouth may be open with tongue protruding
v. Staggering

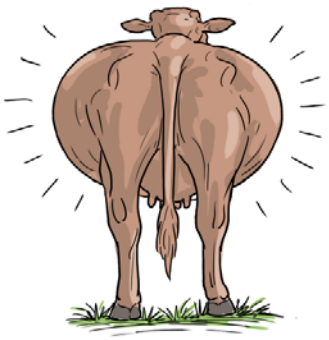

**Fig. 31: Staggering; a sign of bloat in a cow**

**Prevention of Bloat**

Pasture management: Legumes should be introduced into the diet gradually over several days. Avoid cows gorging on new pastures by feeding them on other feeds before letting them out to graze. Silage, hay or more mature pasture can be used to reduce the cow's appetite.

Initially, cows should only be allowed access to the pasture for short periods (one hour or so) and monitored closely during grazing and immediately after removal.

Cutting and wilting the pasture for 2 - 3 hours prior to feeding reduces the risk of bloat.

Preventative medication: Detergents and anti-foaming agents can be drenched prior to grazing.

Treatment

A sharp knife can be used to puncture the rumen on the left side of the animal (at the farm level as an emergency).

Puncturing the rumen with the standard trocar and cannula is a quickest way to release the gas which cannot be expelled with a stomach tube. The trocar is used to puncture while the canula is left in place to release the gas.

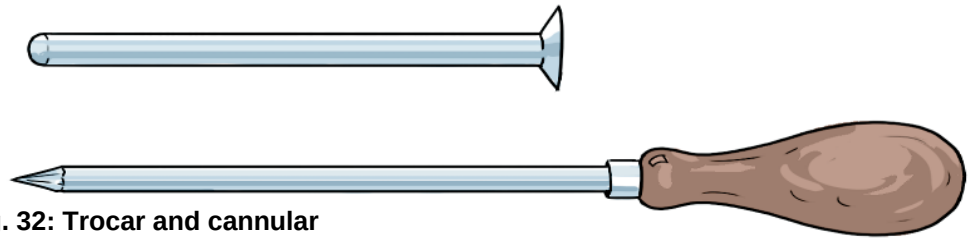

**Fig. 32: Trocar and cannular**

## Internal parasites

### Worms

Worms are internal parasites found mostly in the digestive system of animals. Eggs from the adult worm are passed with the animal's faeces onto the ground where they hatch into larvae and are passed into the animals when they feed on contaminated pasture. While within the animal, the larvae develop into adults, lay eggs and the cycle is repeated. Some worms will pass through another animal (an intermediate host) before getting to the final (definitive) host.

Worms cause several types of damage to the host:

a) They suck the blood of animals and this may lead to death from anaemia (shortage of blood in the body).
b) They consume nutrients causing deficiencies and leading to poor health, growth and production. This is the major negative effect of worms on farm animals.
c) Some worms may block the intestines and small passages in the body interfering with movement of food and flow of digestive enzymes.
d) They cause damage to the cells lining the gut and interfere with production of enzymes and absorption of nutrients.
e) Irritation to cells of the gut may cause diarrhoea and loss of body fluids leading to dehydration, abdominal pain (colic) and loss of appetite.

Worms are generally classified into round and flat worms (see Table 10).

<u>Symptoms of worm infestation:</u>

Symptoms of worm infestation may not be obvious and can easily be ignored or mistaken for other illnesses. They are likely to be most severe during the dry season when animals are not well fed.

**Table 11. Classification of worms**

| Type of worms | Common worms | Where found |
|---|---|---|
| Flat worms | Liver flukes | Bile ducts (liver) |
| | Tapeworms | Muscles |
| | Lungworms | Lungs |
| Round worms | Barberpole worm | Stomach |
| | Brown stomach worm | |
| | Small stomach worm or stomach hair worm | |
| | Thread-necked intestinal worm | Intestines |
| | Small intestinal worms | |
| | Hook worms | |
| | Nodular worms | |

Non-specific signs include:

- Lower than expected weight gain and/or weight loss
- decreased milk production
- lacks of appetite
- Poor body condition.

Specific signs include:

- The animal appears pale around the eyes (anaemia)
- has a dry, dull coat
- Animal may appear to be swollen around the jaws owing to accumulation of body fluid (referred to as 'bottle jaw')
- In some cases, adult worms or tapeworm segments may be seen in the faeces
- Diarrhea (may be bloody), loss of weight, and death may occur.

**Treating worms**

If worm infestation is suspected all animals should treated with broad-spectrum dewormers (antihelmintics). For advice on which type of dewormer to use and the method of administration, one should consult a veterinarian.

There are several types of dewormers containing different preparations of antihelmintics that can be used to control different types of worms. It is advisable to use the correct type of antihelmitic and this is possible through identification of the type of worm by taking a sample of the fecal material to a laboratory.

While in doubt, ask the veterinarian for advice on when to deworm, and which type of dewormer to use.

**Control of worms**

Deworming - routine deworming (every 3 months) is recommended especially at the start of the rains.

# CHAPTER 8: RECORDS

Record keeping is an important activity in any dairy enterprises. Farmers should therefore ensure that all farm activities are recorded promptly. Records are important to farmers because they can help farmers in many ways such as in making:-

- Management decisions
- Financial accounting
- Identifying problems
- Planning for the future
- Determining whether targets are met

In the dairy enterprise, several types of records are kept by the farmer. For a successful operation of a dairy enterprise the following records should be kept by the farmer. Pedigree and numbers of each animal kept on the farm, dates of heat periods, breeding, pregnancy checks, bulls used, animal health records deworming, vaccinations, performance records milk production, growth rates

Good records should have the following characteristics:

i. Easy to update
ii. Easy to understand
iii. Up to date i.e. include the latest event (current)
iv. Easy to access
v. Easily summarised

Several types of records are kept which include:

i. Ancestry or genetic records. These include the maternal and paternal records
ii. Breeding records -sire, date of breeding, pregnancy confirmation, date of calving, and particulars of calf.
iii. Veterinary records - disease type, date and treatment
iv. Production - amount of milk (daily, weekly or monthly), butter fat, drying date.
v. Feed records - these could be amount of concentrate fed for pasture grazed animals or the totals amount fed for zero grazed animals.
vi. Financial records - all financial transactions should be recorded.

**Recording**

Records are important because they give the animal's ancestry and hence prove quality and increase the value of the animal. Records also help farmers in making management decisions. Farmers keep mainly two types of records; pedigree

records which show the ancestry of the animals and performance records. Ancestry records are kept by the Kenya stud Book while performance records for dairy cattle are kept by Dairy recording services of Kenya (DRSK).

Farmers are encouraged to register their animals with Kenya Stud Book and maintain the performance records especially milk, with the Dairy recording services of Kenya.

The following are sample record cards that farmers can keep:

i. Record Card for Daily milk yield
ii. Cow Identification and Health card:
iii. Breeding / Reproduction Card
iv. Calving Record

**Table12. Record Card for Daily Milk Yield**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total milk | Average Per day | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jan** | **AM** | | | | | | | | | | | |
| | **PM** | | | | | | | | | | | |
| **Feb** | **AM** | | | | | | | | | | | |
| | **PM** | | | | | | | | | | | |
| **Mar** | **AM** | | | | | | | | | | | |
| | **PM** | | | | | | | | | | | |
| **Apr** | **AM** | | | | | | | | | | | |
| | **PM** | | | | | | | | | | | |
| **May** | **AM** | | | | | | | | | | | |
| | **PM** | | | | | | | | | | | |
| **Jun** | **AM** | | | | | | | | | | | |
| | **PM** | | | | | | | | | | | |

**Table 13. Cow Identification and Health Card**

| Cow identification | | | Health record | | |
|---|---|---|---|---|---|
| **Cow name** | **Sire** | **Dam** | **Date Born** | **Illness/Event** | **Outcome** |
| Number | | Number | | | |
| Breed | | Breed | | | |
| Birth date | | Sire name | | | |
| Date animal received | | Number | | | |
| Source | | Breed | | | |

| Table 14. Breeding / Reproduction Card | | | | |
|---|---|---|---|---|
| **Lactation No……Date of last calving……** | | | | |
| Date on heat | | | | |
| Service dates | | | | |
| Bull /AI | | | | |
| Breed and owner | | | | |
| Pregnancy check<br>Date and result | | | | |
| Date to dry | | | | |
| Date to calve | | | | |

| Table 15. Calving Record | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ID** | | | | **Birth** | | | **Weaning** | | **12 months** | | **Remarks** |
| **Number** | **Name** | **sex** | **ID** | **Date** | **Wt** | | **Date** | **Wt** | **Date** | **Wt** | |
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# CHAPTER 9: LIFE SKILLS

## How to manage wounds and fractures

A wound is a break in the skin, usually caused by a sharp object. Wounds are caused accidentally or by parasites and other animals (e.g. fights and bites). When left untreated, the exposed tissues may become infected.

Treating a wound involves the following steps:

i. Stop any bleeding.
ii. Clip hair or wool way from the edges of the wound.
iii. Remove all foreign objects. Wash the wound thoroughly with plenty of clean water (the water should have been boiled, cooled and salt or a mild antiseptic added).
iv. Dry the wound with a clean cloth.
v. Put a wound dressing or antibiotic powder on the wound.
vi. When there are a lot of flies about, use a wound dressing that repels flies or kills fly eggs and larvae.
vii. Encourage wounds to drain and pus to come out by pressure and incision if necessary.
viii. If the wound does not heal, becomes black and smells bad, the dead flesh must be cut away. Wash the wound with antiseptic and treat with antibiotic powder.

## Fractures

Fractures (usually to the legs) result from falling into holes, falling over heavy farm implements or jumping over fences. For large, heavy animals or fractures where the bone breaks high up in the leg it is better to slaughter the animal for meat. For young and light animals:

i. Keep the animal quiet and stop it from moving around.
ii. Stop any bleeding.
iii. If the bone has come through the skin, clean the wound and give local anaesthesia by injection.
iv. Arrange the leg so that the broken ends of the bone touch in their normal positions as far as possible.
v. Tie a piece of wood (a splint) to the leg to keep the bones in position.
vi. Confine the animal to reduce movement during the healing period.

Splints can be also made by dipping strips of cloth in mud and egg white and wrapping around the leg. Cover with a strip of tree bark and a fresh goatskin. As it dries, the splint will harden and shrink, holding the broken bones together. Check every day that the fixing is not too tight. If the leg below the splint is cold or very swollen, loosen the fixing and then tighten again carefully, keeping the leg in the same position. Leave the splint on for at least 10 –14 days for a young animal or 21–28 days for an adult animal.

**Disposing of waste and carcasses**

Before handling a carcass, consider the diseases that can be passed to humans (anthrax, brucellosis, rabies, ringworm and mange are the most common ones). If the animal died unexpectedly, a post-mortem will reveal the cause of death and guide the means of disposal. Post-mortems should be performed by qualified veterinarian.

If anthrax is suspected the carcass should be burned and no post-mortem should be carried out.

How to burn a carcass

1. Dig two trenches (2 m long, 40 cm wide and 40 cm deep) in the form of a cross. The trenches will provide oxygen to the fire.
2. Place two iron bars so they lie across one of the trenches.
3. Place strong wooden posts across the bars.
4. Place the carcass and a heap of fuel (wood and straw soaked in waste oil) on the wooden posts.
5. Light the fire and burn the carcass.

<u>Disposal by burying</u>

1. Dig a hole 2 m long by 1.5 m wide and 2 m deep.
2. Put the carcass in the hole and cover with soil and logs or large stones to stop wild animals or dogs digging it up again.

# Dairy Farmers Training Manual