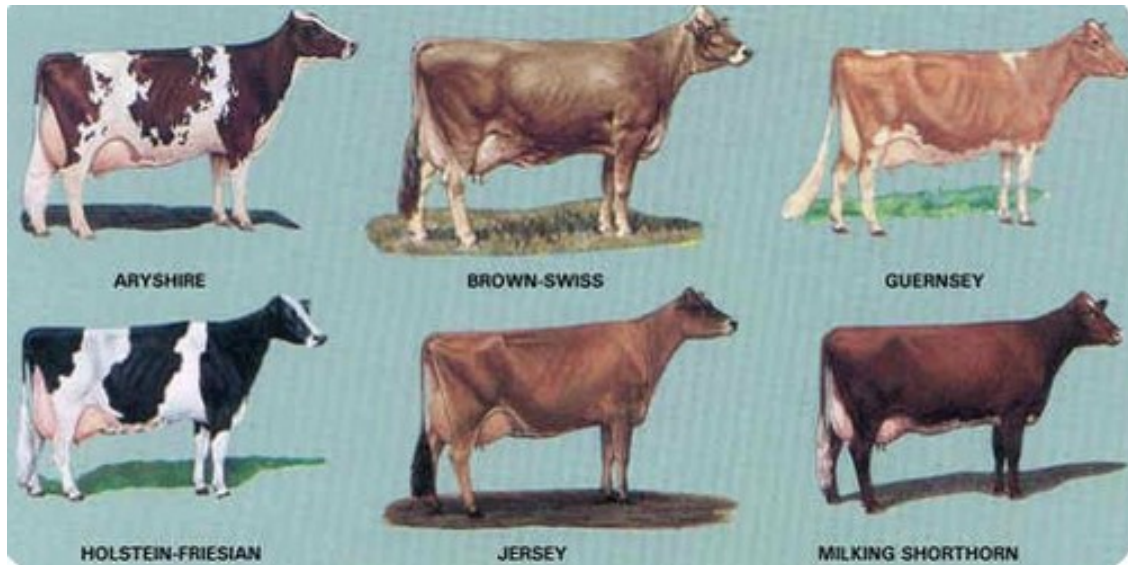




Level-III

Based on March 2022, Version-4 Occupational Standard



Module Title: Conducting Dairy Cattle Production

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Introduction to the module

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This Module cover the skills, knowledge and attitudes required to enter a determine dairy cattle production and productivity, dairy cattle feed and management practices and apply breeding management of dairy cattle.



LG #1

LO #1 Determine dairy cattle production and productivity

This learning guide is developed to provide you with the necessary information regarding the following content coverage and topics:

- Identifying and managing types of dairy production systems
- Describing productivity and economic importance of dairy cattle
- Identifying and describing dairy cattle selection criteria
- Analysis dairy cattle production status
- Perform Animals culling operation

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify and manage types of dairy production systems
- Describe productivity and economic importance of dairy cattle
- Identify and describe dairy cattle selection criteria
- Analysis dairy cattle production status
- Perform Animals culling operation

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”



Information Sheet 1

1.1. Identifying and managing types of dairy production systems

1.1.1. Introduction

World milk production is almost entirely derived from cattle, buffaloes, goats, sheep and camels. Other less common milk animals are yaks, horses, reindeers and donkeys. The presence and importance of each species varies significantly among regions and countries. The key elements that determine the dairy species kept are feed, water and climate. Other factors that may influence the presence of a dairy species are market demand, dietary traditions and the socio-economic characteristics of individual households (e.g., poorer families tend to rely more on small ruminants).

Although cattle are kept in a wide range of environments, other dairy species make dairying possible in adverse environments that often cannot support any other type of agricultural production. Sheep allow milk production in semi-arid regions around the Mediterranean, goats in regions with poor soils in Africa, horses in the steppes of Central Asia, camels in arid lands, buffaloes in wet tropical regions, and yaks in high mountainous areas such as the Tibetan Plateau.

In developing countries, milk producing animals are often raised in subsistence and smallholder systems. These animals are usually multi-purpose and grow and produce under difficult conditions, such as low inputs, minimum management and harsh environments. They are well adapted to local conditions, but have low genetic potential for milk production.

Ethiopia holds the largest cattle population from Africa which has estimated to be about 70 million heads of cattle. Out of total cattle population, the female cattle constitute about 56 percent and the remaining 44 percent are male. About 97.4% of the total cattle in the country are local breeds. The remaining are hybrid and exotic breeds that accounted for about 2.3 percent and 0.31 percent, respectively and there are milking cows are about 15.04 million heads. In 2020/21, there was 4.96 billion liters of cow milk produced per year in the country. Peri-urban and urban performed in areas where the population becomes high, and the agricultural land is scarce and with better management and breed improvement while commercial the pure exotic animals are limited to commercial or government farms per capita consumption of milk is approximately 19 kg per year in Ethiopia.

There are many ways of keeping cattle for milk production. Choose will depend on local conditions, most importantly climate, infrastructure, land availability and local traditions. The one you choose depends very much on the circumstances in your area: climate, type of vegetation, market for selling

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the product, availability of labor and, last but not least, local traditions. Dairy cattle can be reared in ways that vary depending on the resources available to the farmer.

1.1.2. Dairy production systems

An estimated 80 to 90 percent of milk in developing countries is produced in small-scale farming systems. These operations are based on low inputs, so production per dairy animal is quite low. Most milk produced by smallholders in developing countries comes from one of the following production systems:

- **Rural smallholder dairying:** Dairying is often part of a mixed farming system in which manure is used for cash crop production. Dairy animals are fed on grass, crop residues and cultivated fodder. Supplementary feeding is practiced only when feasible.
- **Pastoral/agro pastoral dairying:** These systems are land-based and milk is often the most important subsistence item. Dairy production is generally associated with cropping, but nomadic pastoralists practice little or no agriculture and roam the land in search of grazing grounds and water.
- **Landless peri-urban dairying:** This is a purely market-oriented production system located within and close to the boundaries of cities. Peri-urban dairy producer's benefit from their closeness to markets, but their production is based on purchased inputs and may encounter problems of feed supply and waste disposal. In recent decades, a peri-urban dairy sector has developed very rapidly around the larger cities of many developing countries, in response to expanding market demand. The concentration of milk production in close proximity to urban centers may threaten human health.
- **Intensive dairying:** Dairy herds may spend the majority of their time indoors in modern, well ventilated and light cattle sheds. This is referred to as 'continuous', or 'year round' housing. In some cases, these cows may spend up to three months outdoors during their dry period (the three months before a cow gives birth to a calf), and may have access to pasture for exercise and to socialise. Within these systems each cow is required to have space to move around, a bed to lie in and sufficient space to feed. It is common in housed units for farmers to also provide loafing areas, cow grooming brushes, fans and water sprinklers to ensure maximum cow comfort. Cows that are predominantly housed indoors are fed a diet of freshly cut pasture or silage and mixed ration feed to ensure that all their nutritional requirements are met.

In the intensive system, dairy cattle are enclosed in zero-grazing units where they are provided with all their requirements for feed and water



Advantages

- The cow does not waste energy walking in search of pasture
- It avoids diseases associated with communal grazing
- It allows dairy farmers with no grazing land to produce milk and make money
- The manure use to improving soil fertility and generate biogas

Disadvantages

- The method is labor intensive as feeding and cleaning the unit must be done daily
- The initial cost of putting up a zero-grazing unit is high
- It may be difficult to detect when a cow is on heat, especially a singly housed cow.

In addition to these traditional small-scale milk production systems, some developing countries have large-scale dairy enterprises. Generally, large-scale producers do not account for a large share of national milk production.

1.2.Describing productivity and economic importance of dairy cattle

1.2.1. Productivity of dairy cattle

The productivity of an individual cow is the sum of the value of the milk she produces, the value of her offspring, and her individual market value when she leaves the herd. Many factors influence individual cow productivity, which is also based on longevity and the proportion of the cow's lifetime spent producing milk. Non-productive periods include the period from birth until first parturition and dry periods before subsequent calving. Heifers must be managed to reach appropriate breeding size by 13–15 months of age to maximize lifetime production.

Milk yield is related to stage of lactation. Milk yield increases rapidly after calving, reaches a plateau 40–60 days after calving, and then declines at a rate of 5%–10%/month. The rate of decline is lower in first-parity animals than in older cows. Good reproductive management ensures that the largest proportion of a cow's total lifetime production is spent during early high-producing stages of lactation rather than late, lower-producing periods. Milk yield increases with age and parity until about the sixth lactation; these cows may produce up to 25% more milk volume than first lactation cows. Health disorders or other management problems that reduce longevity have a negative impact on productivity.

It is a well-known fact that the dairy industry actively contributes to the economies of a number of communities, regions and countries. An increasing demand worldwide is noticeably emerging at present, and the industry is globalizing, thus increasing the scope and intensity of the global dairy trade. However, the question of how and on what criteria we can objectively assess the economic benefits of the dairy sector still remains.

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The following factsheet aims to summarize the different aspects of dairy economy, as attested by multiple existing, comprehensive data sources. Economic dairy benefits can be assessed from the point of view of: production of milk and dairy products, trade and employment.

1.2.2. Economic Importance of keeping dairy animals

Some economic importance of keeping dairy animals tremendous nutritional and economic values to man as stated below:

- Milk and Meat of dairy animals are good sources of animal protein to man which are of better quality than plant protein.
- They serve as source of income to subsistence farmers
- They are also used as gifts or bride price which serves as family wealth
- They are sources of gainful employment.
- The manure/dung from these animals can be used as a source of organic fertilizer.
- Cattle, and some other ruminants can also be used as “beast of burden”

1.3. Identifying and describing dairy cattle selection criteria

Dairy producers face a major task when selecting replacement heifers and choosing which cows in the current herd to keep or to sell. Maximizing milk production is the primary goal of dairy producers. When a producer selects females for his or her herd, the decision may affect the operation’s long-term success in the dairy industry because of the longevity and genetic influence of the dairy cow and her offspring.

Factors to be considered during selection of dams:

- Physical appearance
- Health,
- Milk production record
- Pedigree

1.3.1. Physical appearance (Body conformation)

Body condition is defined as the ratio of the amount of fat to the amount of non-fatty matter in the body of the living animal. Body conditions are reflection of the fat reserves carried by the animal. The ability to estimate the body condition more accurately and relate it to milk and milk components production would help the farmers in the selection of dairy animals and to increase the overall efficiency of feeding and management of dairy animals.

Producers should use the score card to help evaluate and select cows for production. It compares cows to an ideal cow, which is given a score of 100 points; they are then classified according to their scores. The classifications are as follows:

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Excellent	90-100 points
Very Good	85-89 points
Good Plus	80-84 points
Good	75-79 points
Fair	70-74 points
Poor	Less than 70 points

- A. Frame (15 points)** - The skeletal parts of the cow, except the feet and legs, are evaluated in this category. Dairy cattle should be tall and long-bodied with a straight, strong back; a long, level rump; and a long, clean neck.
- B. Dairy character (20 points)** - Dairy character provides a prediction of future milk production through the evaluation of milking ability. Dairy cattle should have wide, flat ribs and be lean in appearance, with sharp withers.
- C. Body capacity (10 points)** - Body capacity is an evaluation of the volume of the cow. It determines the amount of feed the animal is able to consume, which affects milk production. Dairy cows should be long, deep, and wide through the barrel and chest floor.
- D. Feet and legs (15 points)** - Looking at the feet and legs allows an individual to evaluate skeletal soundness, or the ability of the cow to move easily.
- E. Udder (40 points)** - The udder is the most important part of the dairy cow. Udders are evaluated for milk production and productivity over time. The cow's udder size, cleft, balance, and teat placement should be considered.

1.3.2. Pedigree selection

Selection on the basis of performance of the ancestors is called as pedigree selection. Pedigree selection is very useful when the traits selected are highly heritable. If a performance record of individual is available, the addition of pedigree information usually adds little to accuracy of estimates of breeding value of individual. Pedigree selection is especially useful for early selection of individuals as in case of selection of young bulls for progeny testing. Limitation of pedigree selection is that the environment under which ancestor records were made several years ago are quite different from the existing environmental conditions when an individual is evaluated for selection.

1.3.3. Progeny testing

Selection of the individuals on the basis of average performance of their progeny is called progeny testing. It is the estimation of an individual by evaluating its off springs. It is very useful tool in evaluating breeding worth of dairy cattle. It offers best means of achieving genetic improvement in traits of moderate to low heritability. The rate of progress achieved by this method is double to that possible by phenotypic selection. Progeny testing is generally used for selecting males as a large

number of progeny can be obtained for each male, while the number of progeny produced by a female is limited. A major limitation of progeny testing is prolonged generation interval as individuals are to be selected only after their test progeny performance is evaluated. It is also very expensive since a large number of animals are to be performance recorded. For practical genetic consideration, the number of unselected daughters studied to evaluate a bull should be between 30 and 50.

1.4. Analysis dairy cattle production status

Different stages of growth, production and reproduction have different nutrient requirements. Generally the highest nutrient requirements are during lactation. The lowest nutrient requirements are during mid to late gestation of the mature female. Growing animals and producing animals have different needs to those of animals that are simply meeting their maintenance requirements.

To be profitable in livestock production these different dietary requirements need to be met as inexpensively as possible.

- Maintenance Requirements
- Requirements for Growth and Production
- Requirements for Breeding
- Requirements for Working Animals
- Requirements for Vitamins and Minerals

Seen from a different perspective, poor livestock keepers attempting to make the best use of limited resources will need to be able to target those resources to obtain the best effect, given a variety of desired outcomes. At the simplest level, the desire is to maintain livestock survival.

1.5. Perform Animals culling operation

There is a well-demonstrated relationship between productivity, profitability, and herd size. One reason for this is the greater willingness for larger operations to adopt production-enhancing technologies. Larger operations can take advantage of economies of scale when purchasing feed and other consumables. Government policies can also substantially influence herd size: countries with supply management systems limit the amount of milk a farm can sell, in an effort to reduce the oversupply of milk and support the price per volume of milk sold. The amount and productivity of pasture can influence the size of herds that use grazing to supply some or all of the nutrient needs of the herd. In these herds, productivity is determined by balancing the ability of the pasture to produce nutrients against the ability of the cows to produce milk. The size of both grazing and confinement herds are increasingly affected by competing demands for land.

The proportion of the herd producing milk versus the non-productive stock (dry cows, calves, heifers, and bulls) has an effect on total herd profitability. Herd composition is the result of a number of

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interrelated management decisions, such as culling policy, rate of reproductive success, rate of disease, replacement management, and long term goals regarding herd size. For instance, a herd may be faced with the need to cull older cattle because of chronic disease problems or because of a low pregnancy rate. If plenty of replacement heifers are available, the milking herd demographics may shift toward younger animals to approach 50% first-lactation cattle. Although these younger animals are genetically superior to the older animals, they will not achieve their production potential until the third or fourth lactation, and the overall herd production will decline.

With the advent of timed insemination programs, older cows are being re-bred and becoming pregnant more successfully. As a result, not as many replacement heifers will be needed, and the herd demographics will shift to favour older more productive cows. In such a situation, herd managers may choose to perform genomic testing of the female young stock and sell animals with lower genetic merit.



Self-check 1

Written test

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

1. Which of these is a dual purpose breed?
 - A. Horro breed
 - B. Jersey
 - C. Holstein F
 - D. Ayrshire
2. The term dual purpose describes cattle that are
 - A. Of two colors
 - B. Bred for milk and draught
 - C. Yield high milk with high fat
 - D. Breed for fat and milk
3. Which of the following processes is given major importance in dairy farm management?
 - A. Increase in yield and quality of milk
 - B. Increase in size of cattle
 - C. Increase in the number of cows
 - D. Increase in number of buffaloes
4. Milk yield does not depend upon which of the following?
 - A. Quality of breeds
 - B. Breeds having high yielding potential
 - C. Resistance to diseases
 - D. Number of cows
5. How can we identify and rectify the problems occurring in a dairy farm?
 - A. Regular inspection of dairy farm
 - B. Cattle should be given their own space and freedom
 - C. By making cattle independent
 - D. By sitting and observing the cattle
6. Ration contains all the nutrients in right proportion and quantities is known as?
 - A. Maintenance Ration
 - B. Balanced Ration
 - C. Reproduction Ration
 - D. Gestation Ration

Test II: Short Answer Questions

1. List the types of dairy production systems.
2. Discuss the advantage and disadvantage of intensive dairy production systems.



Operation Sheet-1

2.1. Performing selection based on body conformation

A. Tools and equipment

- PPE
- Dairy animal
- Crush
- Pen
- Paper

B. Procedures/Steps/Techniques of selection based on body conformation

- Observing the skeletal parts of the cow for structure, length and high of the bone out of 15 points
- Evaluating the dairy character or milking ability with width and flatness of ribs (out of 20 points)
- Evaluating of body cavity or the volume of the cow out of 10 points
- Evaluating the skeletal soundness and strength of the feet and legs out of 15 points
- Evaluating udder size, cleft, balance, and teat placement out of 40 points



Lap test-1

Performance Test

Name.....

ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 120 minutes. The project is expected from each student to do it.

Task-1 Perform selection based on body conformation



LG #2

LO #2 Determine dairy cattle production and productivity

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying digestion system of dairy cattle
- Describing feed sources for dairy cattle
- Recognizing nutrient requirement of dairy cattle
- Preparing feeding plan and formulate
- Describing feeding strategies of dairy cattle
- Undertaking and recording dairy cattle body condition scoring
- Identifying, selecting and preparing facilities and equipment
- Performing new born animals management practices
- Performing heifers management practices
- Performing lactating, pregnant and dry cow management practices
- Identifying and maintaining hygiene, health and environmental requirements
- Carrying out record keeping

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify digestion system of dairy cattle
- Describe feed sources for dairy cattle
- Recognize nutrient requirement of dairy cattle
- Prepare feeding plan and formulate
- Describe feeding strategies of dairy cattle
- Undertake and record dairy cattle body condition scoring
- Identify, select and prepare facilities and equipment
- Perform new born animals management practices
- Perform heifers management practices
- Perform lactating, pregnant and dry cow management practices
- Identify and maintain hygiene, health and environmental requirements
- Carry out record keeping

Learning Instructions:



1. Read the specific objectives of this Learning Guide.
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Information Sheet 2

2.1. Identifying digestion system of dairy cattle

The digestive tract includes the oral cavity and associated organs (lips, teeth, tongue, and salivary glands), the oesophagus, the fore stomachs (reticulum, rumen, omasum) of ruminants and the true stomach in all species, the small intestine, the liver, the exocrine pancreas, the large intestine, and the rectum and anus. Gut-associated lymphoid tissue (tonsils, Peyer's patches, and diffuse lymphoid tissue) is distributed along the GI tract. The peritoneum covers the abdominal viscera and is involved in many GI diseases. Fundamental efforts to manage GI disorders should always be directed toward localizing disease to a particular segment and determining a cause. A rational therapeutic plan can then be formulated.

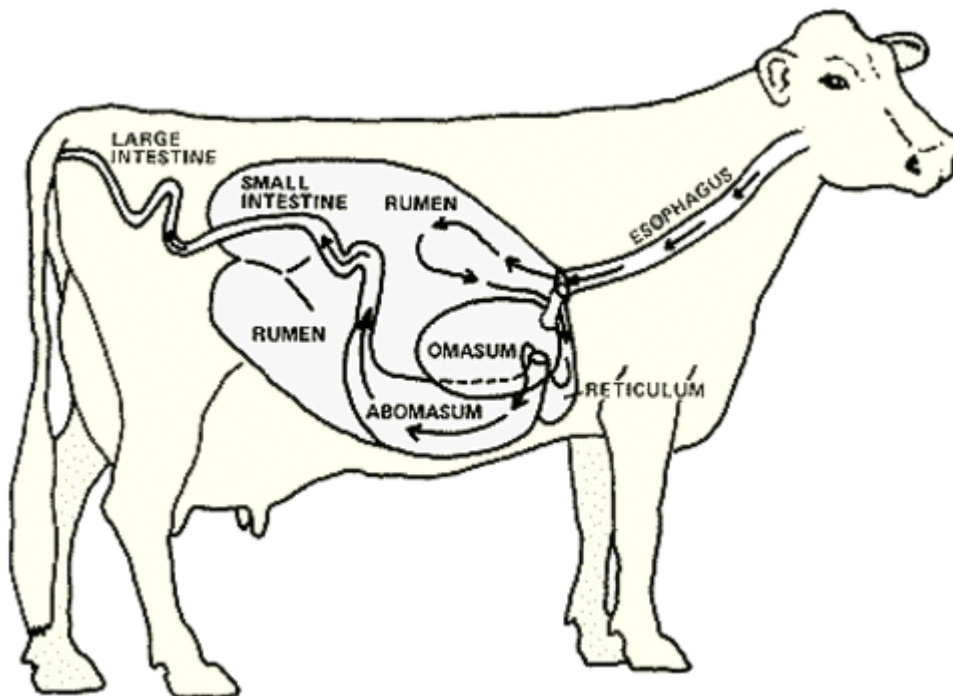


Figure 2.1: The cow's digestive tract

The cow's digestive tract consists of the following:

- Mouth
- Oesophagus
- A four-compartment stomach, which includes
 - The rumen (paunch)
 - The reticulum ("honeycomb")
 - The omasum ("manyplies")
 - The abomasum ("true stomach")

- Small intestine
- Large intestine

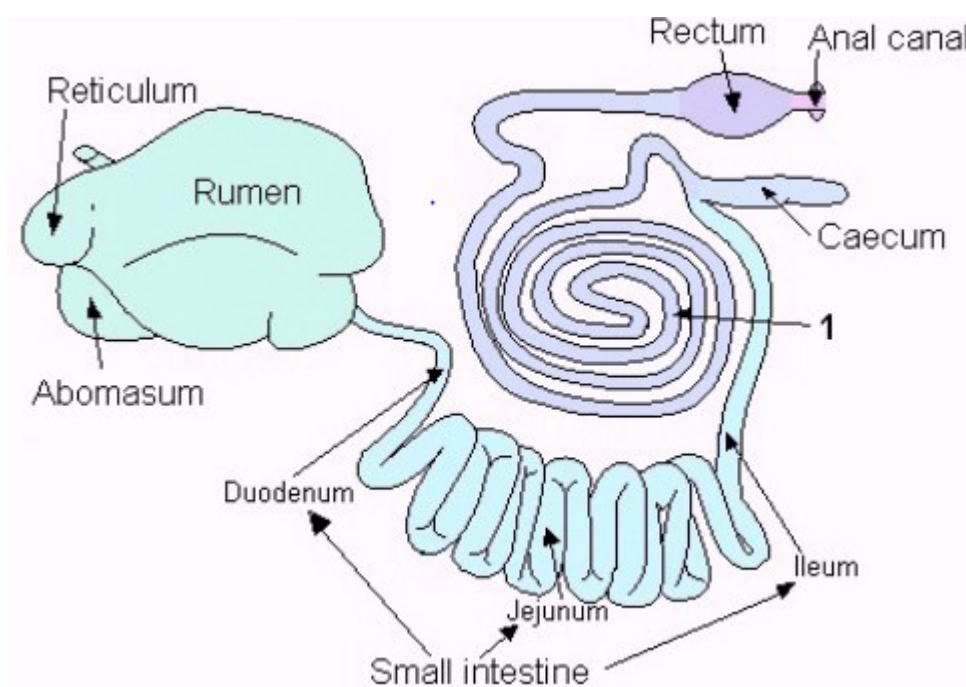


Figure 2.2: Schematic representation of ruminant's digestive system

Ruminant:

- Ruminant stomachs have four compartments: the rumen, the reticulum, the omasum and the abomasum.
- Rumen microbes ferment feed and produce volatile fatty acids, which is the cow's main energy source. Rumen microbes also produce B vitamins, vitamin K and amino acids.
- In calves, the esophageal grooves allow milk to bypass the rumen and directly enter the abomasum. Rumen development occurs following a change in diet and microbial growth.

The primary functions of the GI tract include pretension of food and water; mastication, salivation, and swallowing of food; digestion of food and absorption of nutrients; maintenance of fluid and electrolyte balance; and evacuation of waste products. These functions can be broadly characterized as:

- | | |
|-------------|--------------|
| • Motility | • Absorption |
| • Secretion | • Blood flow |
| • Digestion | • Metabolism |



2.2. Describe feed sources for dairy cattle

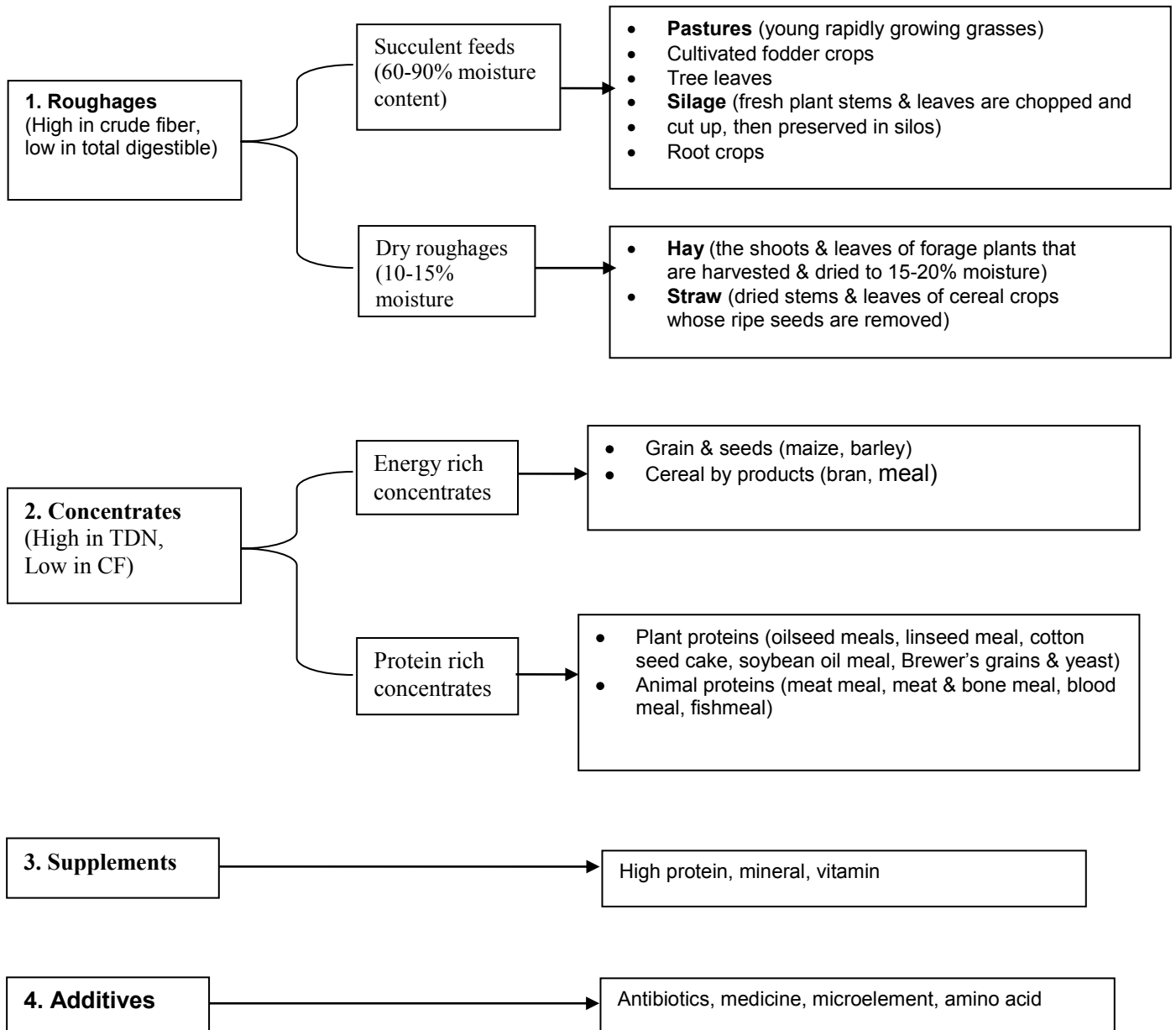


Diagram 2.1 classifications of feed sources

This classification is a convenient way to group feeds, but it is somewhat arbitrary.

Classifying feeds is not as important as knowing which feeds are available, their nutritive value, and the factors that affect their utilization in a ration.

2.2.1. Roughages

I. Forages

In general, forages are the vegetative parts of grasses or legume plants containing a high proportion of fiber (more than 30% neutral detergent fiber). They are required in the diet in a coarse physical form (particles with a length of more than 2.5 cm) to help rumen function.

Usually, forages are grown on the farm.



They may be grazed directly or harvested and preserved as hay or silage. Depending on the cow's stage of lactation, they should contribute from almost 100% (for non-lactating cows) to no less than 35% (for cows in early lactation) of the ration dry matter. The general characteristics of forages are as follows:

- **Bulky:** Bulkiness puts limits on how much a cow can eat. The energy intake and the milk production of a cow may be limited by too much forage in a ration. However, bulky feeds are essential to stimulate rumination and maintain the health of the cow.
- **High Fiber and Low Energy:** Forages may contain from 30 to 90% fiber (neutral detergent fiber). In general, the higher the fiber in forage, the lower the energy content of the forage.
- **Variable in Protein:** Depending on the stage of maturity, legumes may contain 15 to 23% crude protein; grasses typically contain 8 to 18% crude protein (depending on the level of nitrogen fertilization), and crop residues may have only 3 to 4% crude protein (straw).

From a nutritional standpoint, forages may range from very good feeds (lush young grass, legumes at a vegetative stage of maturity) to very poor feeds (straw, browse).

A. Grasses and Legumes

High quality forage can make up two-thirds of the ration dry matter with cows eating 2.5 to 3% of their body weight as forage dry matter (for example, a cow of 600 kg, can eat 15 to 18 kg dry matter of good quality forage). Cows usually eat more legumes than grasses at similar stages of maturity. However, good quality forages fed in balanced diets will supply much of the protein and energy needed for milk production.

The feeding value of forages is greatly influenced by the growth stage when harvested or grazed. Growth can be divided in three successive stages:

- Vegetative stage;
- Flowering stage;
- Seed formation stage

The maximum yield of digestible dry matter of a forage crop is obtained:

- At the late boot to early head stage of maturity for grasses;
- At the mid-to-late bud stage of maturity for legumes;
- Before the grains are fully dented for corn and sorghum.

There is little that can be done to prevent the loss of nutritive value of forage with advanced maturity. For each day of delayed harvest after the optimum stage of maturity, the potential milk production of cows eating the forage will be penalized. However, various strategies can be used to maintain the availability of forage that has good nutritive value:



- Develop a grazing strategy that matches the number of animals in a pasture with the rate of growth of the grass;
- Plant a mixture of grasses and legumes that have different rates of growth and maturity throughout the season;
- Harvest at an early stage of maturity and preserve as either hay or silage;
- Feed lower quality forage to the dry cows or the cows in late lactation and the good quality
- Forage to the cows in early lactation.

II. Crop residues and industrial by- products of poor feeding value

Crop residues are the parts of the plants that remain in the field after harvesting the primary crop (e.g., corn stover, cereal straw, sugar cane bagasse, peanut hay). Crop residues may be grazed, processed as dry feed, or made into silage. Some general characteristics of most crop residues are:

- Inexpensive bulk feed;
- High in indigestible fibre because of high lignin content (chemical treatments can be used to upgrade their feeding value);
- Poor in crude protein;
- Need to be supplemented properly, especially in protein and minerals;
- Need to be coarsely chopped when harvested or at feeding time;
- Should be included in ration of non- lactating animals with low energy requirements.

2.2.2. Concentrates

There is no good definition for the word concentrate. However, they may be described by their characteristics as feeds and their effect on rumen function. Usually, concentrates have the following characteristics:

- They are low in fibre and high in energy.
- They can be either low or high in protein. Cereal grains contain <12% crude protein, but oilseed meals (soybean, cotton, peanut), referred to as protein feeds, can contain > 50% crude protein.
- They have a high palatability and are usually eaten rapidly. As opposed to forage, concentrates are feed that usually have a low volume per unit of weight (high specific gravity).
- As opposed to forages, they do not stimulate rumination.
- They usually ferment faster than forages in the rumen and they increase the acidity (reduce the pH) of ruminal contents which may impede normal fibre fermentation.
- When they comprise more than 60 to 70% of a ration, they may cause health problems

Dairy cows with high genetic potential for milk production also have high requirements for energy and protein. Given that cows can eat only a certain amount per day, forage alone cannot supply the



required amount of energy and protein. Generally, the purpose of adding concentrates to the ration of dairy cattle is to provide a concentrated source of energy or protein to supplement the forage and meet the animal requirements. Thus concentrates are important feeds that allow for formulating diets that will maximize milk production. In general, the maximum amount of concentrates a cow can receive per day should not exceed 12 to 14 kg.

A. Energy rich concentrates.

- Grains (maize, sorghum, wheat, barley, teff, oats, etc.)
- Grain processing by-products (wheat bran, rice bran, maize gluten, etc.)

The various milling by-products obtained through processing wheat are of great interest as livestock feed for state farms, city dairy holders, and to a lesser extent for some dairy co-operatives. Wheat grain is processed in big mills, whereas in the case of teff, barley, maize and sorghum the whole grains are processed and used for food.

- Root crops (cassava, potato, beets, potatoes, turnips etc.)
- Left over bread, by-products from the baking industry
- Sugar industry by-products (molasses, beet pulp)
- Beer industry by-product (brewer's grain). Brewer's grains are traditionally valued for lactating cows because of their palatability and milk-producing property. In addition to commercial beer production small-scale home brewing is also practiced.
- Apples, carrots, onions, fodder beet, pumpkin, banana, citrus pulp, other fruit by-products, etc.

B. Protein rich concentrates.

Industrial by-products (mainly oilseed meals, cotton seed cake, etc.) oil cakes are an excellent concentrate feed for ruminant livestock and have a high level of by-pass protein. The processing of oil seed is widely practiced on a family basis or in small village mills.

- Products of animal origin (blood meal, meat and bone meal, feather meal, fish meal)
- Mixed compound feeds



Figure 2.3 concentrates animal feed

2.2.3. Minerals and vitamins

Minerals and vitamins are of great importance in nutrition. For example, milk fever in early lactation is due to an imbalance in calcium metabolism, and phosphorus is essential for high herd fertility. Deficiencies may result in large economic losses. In lactating dairy cows, the macro-minerals of concern are sodium chloride (NaCl), calcium (Ca), phosphorus (P), and sometimes potassium (K), magnesium (Mg) and sulfur (S). Also, most micro minerals (e.g., iodine, selenium) are required to achieve optimal production and reproduction. The small amount of micro- minerals usually required in a dairy ration is often included as a premix in the concentrates or as fortified salt.

All feeds, except urea and fat, contain at least limited amounts of minerals. Because legumes contain more calcium than grasses, diets based on legumes will require less calcium supplementation. Molasses is rich in calcium and animal protein by-products containing bones are good sources of calcium and phosphorus. Salt (sodium chloride) is a mineral supplement that can be offered free-choice. A mineral mix containing calcium, phosphorus, or both (e.g., dicalcium phosphate) may be required depending on the ingredients in the ration.

Green forages usually contain low levels of phosphorus relative to the cow's needs.

Corn [maize] silage contains little calcium and phosphorus and both minerals are required in the mineral supplement mix.

The amount of mineral mix required in the diet usually ranges from 0 to about 150 g/cow/day. Vitamin A, D, and E are of concern, with vitamin A the most likely to be deficient in areas with long winters or long dry seasons. Rumen microbes synthesize B complex vitamins, vitamin C, and vitamin K, so these vitamins are not usually required in the diet.

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2.3. Recognize nutrient requirement of dairy cattle

During lactation, dairy cows have very high nutritional requirements relative to most other species. Meeting these requirements, especially for energy and protein, relative to intake capacity is challenging. Diets must have sufficient nutrient concentrations to support production and metabolic health, while also supporting rumen health and the efficiency of fermentative digestion.

A. Feed Intake

The cornerstone of dairy nutrition is managing feed intake relative to absolute nutrient requirements. Feed intake (dry-matter intake) and feed efficiency (milk production [absolute or component corrected] per unit of dry-matter intake) are key nutritional monitoring metrics. Dry-matter intake is influenced by the following factors:

- **Feed compositional factors:** neutral detergent fiber (NDF) content, quality of ensiled feeds (excessive moisture and fermentation products), maturity (lignification) of forage, palatability attributes, and nutrient availability
- **Cow physiologic factors:** age, body size, physiologic state, body condition score, days in lactation, and production level
- **Management factors:** feed bunk management (feed delivery, availability, and consistency), grouping strategies, cow comfort, and heat abatement strategies

B. Energy and protein requirement for maintenance and lactation

Feed requirements of dairy cattle vary according to their production stage and age categories. Cows produce approximately half of their total milk yield during the first 100 days of lactation. For this reason it is essential to feed cows properly during the early days of lactation. Feed intake is poor at the beginning of lactation but improves as lactation increases. As feed intake is not proportional with milk production requirements the cow possesses the unique ability to utilize her body reserves for milk production.

The lactating cow usually losses weight at the beginning of lactation as a result of withdrawal of her body reserves until a point when she reaches her peak. Cows can even under good feeding conditions lose as much as 66 kg in body mass during the first three months of lactation. From 120 days after calving the body mass gradually increases until calving. Adult cow, which is not producing still, needs nutrients to survive.

These nutrients are required for vital body functions, like respiration, blood circulation, maintaining the body temperature, etc. and also for movement. The nutrients needed for this purpose are called the maintenance requirement of the cow. If a cow receives less than its maintenance requirement, it reduces its reserves of body fat and it starts to lose weight. The following table shows the maintenance requirements of adult cows of different body weight.

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Table 2.1: Maintenance requirements of adult cows per day

BODY WEIGHT	PROTEIN G CP	TDN (G)	ME MJ
200	233	1900	34.5
250	256	2200	38.7
300	276	2500	42.9
350	299	2800	47.2
400	321	3100	51.4
450	344	3400	55.7
500	366	3700	60.0
550	389	4000	64.2
600	411	4300	68.4
650	434	4600	72.7
700	456	4900	76.9
750	479	5200	81.2
800	501	5500	85.4

When a cow is producing (giving milk), extra nutrients are needed above the maintenance level. These extra nutrients needed for production make up the production requirements of the cow. In the next table the amount of CP and TDN is shown which a cow needs to produce one (1) kg of milk. The production requirements are related to the fat content of the milk.

Table 2.2: Production requirements per kg of milk

% FAT IN THE MILK	PROTEIN G CP	TDN (G)	ME MJ
2.5	72	255	4.19
3.0	78	280	4.53
3.5	84	305	4.87
4.0	90	320	5.21
4.5	96	340	5.55
5.0	102	365	5.89
5.5	108	390	6.23
6.0	114	415	6.57
6.5	120	440	6.91
7.0	126	465	7.25
7.5	490	490	7.59
8.0	510	510	7.93



Example:

A cow weighs 500 kg and produces 10 kg milk/day. The milk contains 4 % fat. What are the total TDN and CP requirements of this cow?

For maintenance the cow needs: 366 g CP

3700 g TDN

For production the cow needs: $10 \times 90 = 900$ g CP

$10 \times 320 = 3200$ g

The cow's requirements are: $366 + 900 = \underline{1266 \text{ g CP}}$ and $3700 + 3200 = \underline{6900 \text{ g TDN}}$

C. Feeding of dry and pregnant animals

The aim of feeding the pregnant cow is to:

- Get the cow into good condition at calving
- Produce a good calf and
- Have reserves to produce milk during early lactation.

If pregnant animals are underfed, they will be in poor body condition when they give birth and begin lactating. Milk production will be significantly reduced. They will also be slow to start cycling again. Underfed animals may also give birth to light weight and/or weak offspring.

Overfeeding pregnant animals can also cause undesirable outcomes:

- Dams may have fat deposits and poor muscle condition that interfere with giving birth.
- Over conditioning also puts animals at risk of pregnancy ketosis and/or fatty liver syndrome.
- Fat young stock may have reduced milk production due to the deposition of fat in the udder.

Transition cows should not have to walk long distances to obtain water. Water is the most important nutrient. Watering devices must be kept clean. A dry period of approximately 60 days between lactations is essential for fair milk production. In short, the dry period is the time from the end of lactation until the cow calves again. Many farmers have a tendency to neglect their cows during the dry period. The cow should be dried off about two months before the expected calving date.

The reasons for drying off are:

- The nutrient requirement of the fetus is high during the last months of gestation
- To replenish body with nutrients depleted during lactation and good body condition at calving.



- To repair and regenerate the alveolar system, the milk secretor cell.
- To gain new stimulation for following lactation as a result of parturition
- To produce colostrum, this is indispensable for the calf during the first days after calving.

D. Feeding of milking cows in different stages of lactation

Several changes occur in cows as they progress through different stages of lactation.

As well as variations in milk production, there are changes in feed intake and body condition, and stage of pregnancy.

a) Feeding of a cow during early lactation

Immediately after calving, the cow needs many nutrients to recondition the body as well as to support milk production. During the first and second month after calving, the cow produces a high amount of milk per day.

Feeding of good quality roughage and a high rate of supplementation with concentrates (noug cake and wheat bran for example) is needed to achieve a high milk production.

Increasing concentrate supplementation in a gradual way after calving will increase nutrient intake and make sure the cow will continue to eat enough roughages. With high quality roughage 8-10 litres of milk per day can be obtained while it is only 2-3 liters per day on poor quality hay and straw.

Poor feeding in the early lactation results in:

- Low lactation yield,
- Poor condition
- Delayed heat or no heat signs at all (leads to poor fertility) and
- Low fat test and ketosis

Therefore, improve the feeding system of the cow at early lactation through providing good quality roughages.

b) Feeding of a cow during mid and late lactation

After the cow has reached peak production, the milk yield will drop gradually. As a result, the energy requirement is less demanding during this stage. Sharp increase in feeding in mid lactation will result in an increase in body mass (fattening) rather than in an increase in production especially in poor productive cows. If a cow is not fed well during early lactation, maximum production will not be obtained.

Milk production requires a lot of energy. If not enough energy is provided to milking cows it will:

- Loose body condition, become thin and weak.
- Milk yield will drop.
- Pregnant cows may become ill after calving
- The calf is likely to be small



If too much energy in the diet of milking cows the animal will become fat which lead to increased incidence:

- Difficult birth
- Retained placenta
- Displaced abomasum
- Milk fever and ketosis

Cows cannot store much protein in their bodies and so it must be supplied in the daily ration in order to maintain high milk production.

Too little protein in the ration/imbalanced rations can lead to:

- A rapid drop in milk production if the amount of protein in the ration is suddenly reduced.
- Rations providing far too little protein will also cause excessive weight loss in milking cows, in case of sufficient energy levels and low protein levels cows might also fatten
- Rations for dry and pregnant cows having too low protein levels will result in small calves being born.

E. Mineral requirements

Two categories of minerals are needed, Micro/trace minerals and Macro minerals. There are seven macro minerals that need to be analyzed and balanced within a cow's diet.

These are calcium (Ca), phosphorus (P), magnesium (Mg), sulfur (S), sodium (Na), chlorine (Cl) and potassium (K). Some of these minerals work together, while others work independently.

Trace or micro minerals include cobalt, copper, iodine, iron, manganese, selenium and zinc. These minerals are added as milligrams per day and expressed as parts per million (PPM) in the ration dry matter. Trace minerals or micro-minerals are needed for blood synthesis, hormone structure, normal reproduction, vitamin synthesis, enzyme formation, and immune system integrity. A major challenge for nutritionists and dairy managers is deficiencies do not immediately impact milk yield or growth.

Reduced reproductive performance or impaired health can take several months before a deficiency appears.

Table 2.3: Function and deficiency signs of macro and micro elements

Macro minerals	Function	Deficiency signs
Calcium (Ca)	Bone & teeth formation, blood clotting, smooth muscle contraction teeth	Rickets, slow growth, bone fractures, lower milk yield, milk fever (hypocalcaemia)
Phosphorus	Bone & teeth formation, energy metabolism, part of DNA	Rickets, poor growth, impaired reproduction, depraved appetite
Sodium	Acid-base balance, muscle	Abnormal eating behavior



	contraction, nerve transmission, osmotic pressure, blood pH	(pica), urine licking, poor appetite, lower milk production
Chlorine	Regulate osmotic pressure and acid-base balance, manufacture of hydrochloric acid	Loss of appetite, weakness, craving for salt, blood alkalosis
Potassium	Osmotic pressure, acid-base balance, nerve transmission	Loss of hair glossiness, decreased feed intake
Magnesium	Enzyme activator, bone and muscle, muscle contraction	Muscle hyper-irritability, salivation, convulsions, grass tetany
Sulfur	Sulfur-containing amino acids, B-vitamins, cellulose digestion, acid-base balance	Reduce microbial growth, poor appetite
Micro minerals		
Cobalt (Co)	Synthesis of vitamin B12 by the rumen microbes	Poor appetite, anemia, rough hair coat
Copper (Cu)	Enzyme activation, blood synthesis, nervous system	Rough hair coat, change in hair color (grey or reddish), diarrhea, immune system impairment, mastitis
Iodine (I)	Synthesis of thyroxine (hormone)	Goiter, big neck in calves, reduced metabolic rate, poor reproductive performance
Iron (Fe)	Part of blood hemoglobin, enzyme systems, immune system function	Anemia
Zinc (Zn)	Enzyme activation, repair of damaged tissue, immune system, teat keratin formation	Parakeratosis of the skin, elevation in somatic cell count, mastitis, hoof dis-function, stiff joints

F. Vitamins

Dairy cattle require the same vitamins as non-ruminants. However, because of synthesis in the rumen and tissues, most vitamins are not needed in the diet of dairy cattle which have a functioning rumen.



Rumen microbes synthesize enough B vitamins and vitamin K to meet the usual needs except for young calves. Vitamin C is synthesized in the tissues of cattle and, thus, is not needed in the diet. Dairy cattle of all ages must have a source of vitamins A and E in the diet. Likewise, vitamin D must be in the diet or synthesized in the skin under the influence of ultraviolet irradiation in sunlight.

G. Water requirements

Water is essential for all categories of livestock. Whereas an animal deprived of food can survive for a considerable time, without water it will die in a few days. Preferably livestock should always be able to drink water when they want to. Unfortunately this situation is not always there and the farmer has to supply water to the animals. Under those conditions cows should be supplied with water at least 2 times per day.

Other factors which will influence the water intake are climatic conditions (hot and dry versus cold and wet) and the DM content of the supplied feedstuffs (hay versus fresh grass). Also the physiological status of the cow (lactating, pregnant or dry) & mineral content of the ration influences the intake.

In general the water requirement, including the water in the feedstuffs, of dairy cattle is as follows:

- | | | |
|------------------------------------|----------|----------------|
| • Calves | 5 – 15 | liters per day |
| • Young stock (1 – 2 years of age) | 15 – 35 | liters per day |
| • Dry cows | 30 – 60 | liters per day |
| • Lactating cows: | | |
| ✓ Up to 10 kg milk | 30 – 60 | liters per day |
| ✓ Up to 20 kg milk | 70 – 100 | liters per day |
| ✓ Up to 30 kg milk | 90 – 150 | liters per day |

Water intake depends to a large extent on the ambient temperature and the body weight. Under hot conditions the intake will be higher.

2.4. Prepare feeding plan and formulate

2.4.1. Dry matter intake

The dry matter intake depends on a number of factors:

I. The cow

- **Level of milk yield:** A high-yielding cow takes in more kg DM than a low yielding cow.
- **Weight:** A heavy cow has a higher DM intake than a light cow.
- **Age:** The DM intake of a heifer is around 2 kg less compared to an adult cow. As age increased dry matter (feed) intake decrease and milk yield decreased



- **Lactation stage:** On the last period Lactation stage dry matter intake decrease and milk yield decreased
- **Breed:** Dry matter intake is proportional to body weight of dairy cow; exotic breed DM intake is high than local breed.
- **Individual differences**

II. The feed

- **Quality of the feed:** The better the quality of the roughage, the higher the intake will be.
- **Taste and smell:** Moulds, butyric acid, ammonia, etc. in roughage will reduce the intake. Also in pastures where manure has been applied will have a negative effect.
- **Digestibility:** Feedstuffs which digest slowly will remain longer in the rumen.
- **Quantity of concentrates fed:** Concentrates will reduce the roughage intake to some extent, but it will increase the total DM intake.

III. Feed supply

- Grazing system: unlimited, limited or zero grazing
- Rationed or “unlimited” feeding
- Variation in the ration
- Transition, e.g. from a summer to a winter ration, has to be implemented gradually
- Frequency of feeding

IV. Environment

- **Temperature:** Particularly too high temperatures will reduce feed intake.
- **Weather:** In wet weather grass is less palatable, especially in the autumn season.
- **The possibility for cows to rest and eat quietly, without disturbances:** An overcrowded shed will lead to more fighting among cows which will affect the DM intake.
- Thumb rules for estimating the DM-intake from roughages are (*):
 - ✓ Poor quality roughages 1.5% of live weight
 - ✓ Average quality roughages 2.0% of live weight
 - ✓ Good quality roughages 2.5% of live weight

Thumb rules are only valid if the animals are given unlimited roughages (roughage leftovers should be at least 5 -10%)! When the roughage ration is supplemented with concentrates the total DM- intake will go up. The maximum dry matter intake from roughages and concentrates is around 3.5 % of her body weight.

The minimum amount of DM an average cow should have daily to meet maintenance and some production requirements are 2% of her live weight!



2.4.2. Steps to be taken in calculating and balancing a ration

A ration should be calculated step by step. The first step is:

- Estimate the average roughage quality available for the animals.
- With this estimated average roughage quality the average DM-intake can be calculated with the “thumb rules”. If an animal does not get unlimited roughage then calculate with the actual quantities given. In this situation always check whether the quantities fed are meeting the minimum DM requirements of the animal. In general, in case enough roughage is there, calculate with a dry matter intake of 2% of live weight out of roughage.
- Calculate the kg TDN and g CP available in the roughage. If an animal is also getting a certain amount of concentrates, then add this feeding value as well (the roughages and concentrates which are “always” fed are also called the “basic ration”).
- Calculate the maintenance and production (milk, growth or calf) requirement of the animal.
- Calculate whether the ration is in balance as far as energy is concerned. In general there will be an energy shortage. If so, then calculate how many Kg of concentrates are required. One can then use the thumb rule of 1 kg concentrate for 2 kgs of milk.
- Then check whether the protein in the total ration and the protein requirement are in balance. If not adjust the composition of the supplemented concentrate (or change, if possible, part of the roughages).

In case rations have to be calculated for high productive cows also check whether the maximum feed intake capacity has been reached/exceeded. Sometimes such cows cannot be fed according to their requirement because the maximum feed intake has been reached. These cows usually produce extra milk out of their body reserves (a weight loss of 25 – 30 KGs during the first 2 - 3 months of lactation is quite common with the HF breed):

- Roughage is of poor quality.
- The cow will eat 1.5 % of her body weight of the straw, which is 6 kg DM.
- 6 kg DM straw provides the following amount of energy and protein :
 - ✓ $6 \times 0.44 = 2.64$ kg TDN
 - ✓ $6 \times 36 = 216$ g CP
- Maintenance requirement is:
 - ✓ 3.1 kg TDN and 321 g CP
 - ✓ Production requirement for 4 kg milk, 4% fat is:
 - $4 \times 0.32 = 1.28$ kg TDN
 - $4 \times 90 = 360$ g CP
 - ✓ Total requirement of the cow is:



- $3.1 \text{ kg TDN (maint.)} + 1.28 \text{ kg TDN (product.)} = 4.38 \text{ kg TDN}$
- $321 \text{ g CP (maint.)} + 360 \text{ g CP (product.)} = 681 \text{ g CP}$
- Total requirement minus what is available in the straw is:
 - ✓ $\text{kg TDN} - 2.64 \text{ kg TDN} = 1.74 \text{ kg TDN shortage}$
 - ✓ $681 \text{ g CP} - 216 \text{ g CP} = 465 \text{ g CP shortage}$
 - ✓ Necessary concentrates (kg) to fulfill the requirements is:
 - $1.74 \text{ kg TDN shortage} / 0.7 \text{ kg TDN (energy value 1 kg concentrates)} = 2.5$
 - To fulfill the energy requirement 2.5 kg concentrates are necessary.
 - ✓ The protein content per kg concentrate should be $465 / 2.5 = 186$.
 - ✓ The protein content of the concentrate is 180 which is roughly adequate

2.4.3. Formulation of concentrate mixtures on the farm

Example No. 1

Suppose that a concentrate feed is required with a medium protein content of 180 g CP and at least 700 g TDN/ kg. The ingredients available are:

Feeding value per kg product

	Kg TDN	g CP
Wheat bran	0.650	152
Sunflower heads	0.733	114
Cottonseed cake with hulls	0.755	242

First the difference between the desired CP content and the content of each ingredient is calculated:

Wheat bran	$152 - 180$	$= - 28$
Sunflower heads	$114 - 180$	$= - 66$
Cottonseed cake with hulls	$242 - 180$	$= + 62$

These differences must be combined in such a way that they add up to about zero.

Then the overall mixture will have the desired CP content:

Wheat bran	- 28	x 2	- 56
Sunflower heads	- 66	x 1	- 66
Cottonseed cake with hulls	<u>+ 62</u>	<u>x 2</u>	+ 124

The desired concentrate comprises of 2/5 wheat bran, 1/5 sunflower heads and 2/5 cottonseed cake with hulls. For checking whether the above answer is correct 5 kg mixture can be prepared:

	Kg TDN	g CP
Wheat bran contributes	$2 \times 0.650 = 1.300$	$2 \times 152 = 304$
Sunflower heads contributes	$1 \times 0.733 = 0.733$	$1 \times 114 = 114$
Cottonseed contributes	$2 \times 0.755 = 1.510$	$2 \times 242 = 484$



Total: 3.543 902

Per kg mixture there is $3.543/5 = 709$ kg TDN and $902/5 = 181$ g CP. This meets the requirement.

If a 100 kg of the mixture is required then:

Wheat bran contributes	$2/5 \times 100 =$	40 kg product
Sunflower heads contribute	$1/5 \times 100 =$	20 kg product
Whole cotton seed contributes	$2/5 \times 100 =$	<u>40 kg product</u>
		100 kg mixture

The same calculation can be made with the feeding values on DM basis. In that case the quantities given should be converted from DM to “product”, i.e. the water content of the feeds should be taken into account. However, most dry ingredients of concentrate feeds have about the same DM content of 90%. The proportions of ingredients calculated on a DM basis will therefore remain the same as for the “product” basis.

Note that the above mixture has a high proportion of whole cottonseed, which has a high fat content. Cows should therefore not be fed more than 6 -7 Kg of this mixture.

Higher intakes could upset the working of the rumen. The fiber content of this mixture is rather high, but the cost will probably be low

Example No. 2

The Pearson square method with 2 ingredients is also used to determine the proportion of 2 ingredients to achieve a specific nutrient content in the mixture

Example: Determine the right combination of lentil straw (7.7% CP) and tella atela (20.2% CP) to create a mixture containing 13% CP.

Steps in using the Pearson Square Method:

Step 1

- Draw a square with lines connecting the opposite corners.
- Write the desired percent of crude protein (13) in the center of the square.

Step 2

- Write the feeds to be used and their crude protein percent at the left hand corners of the square.

Step 3

- Subtract the smaller number from the larger, along the diagonal lines. Write the differences at the opposite end of the diagonals.
- The difference between the percent protein in the lentil straw and the percent protein in the ration are the parts of tella atela needed.
- The difference between the percent protein in the tella atela and the percent protein in the ration are the parts of lentil straw needed.



- The sum of the numbers on the right equals the difference in the numbers on the left. This fact is used as a check to see if the square is set up correctly.

Divide the parts of each feed by the total parts to find the percent of each feed in the ration. Hence, the percentage of lentil straw and Tella atella to be mixed will be as follows:

$$\text{Lentil straw} = (7.2/12.5) \times 100 = 57.6\%$$

$$\text{Tella atella} = (5.3/12.5) \times 100 = 42.4\%.$$

The technique is applicable when the nutrient content of one of the two feeds is lower and that of the other is higher than the target nutrient level shown in the center of the square.

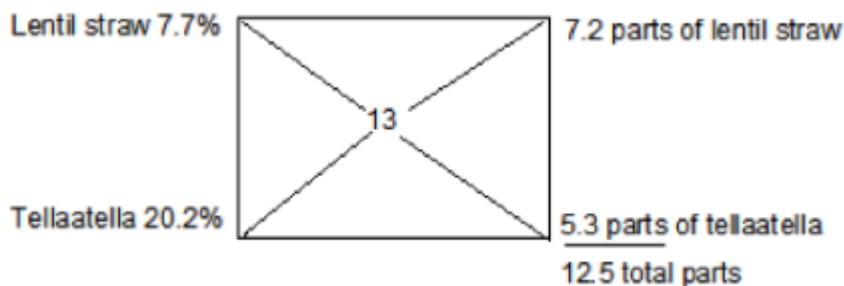


Diagram 2.2 Pearson square method of feed formulation

2.4.4. Planning for dry season feeding

An important feeding management objective is to have at all times enough quantity and preferably also quality roughages available to feed your animals all the year round.

This requires careful planning which often is neglected. To make sure enough roughage is available in the dry season roughage has to be conserved during the growing season in the form of hay or silage besides dried crop residues. The following steps should be followed in this planning process:

- Determine the average herd composition during the dry season.
- Estimate the average roughage quality which will be available during the dry season.
- Estimate the average dry matter intake of each animal category depending on the average roughage quality.
- Based on the numbers calculate how much dry matter is required. Include minimum 5% wastage.
- Determine how much dry matter will be available from crop residues and communal grazing.
- Total amount from “d” – “e” = the amount of roughage to be conserved during the growing season or purchased.
- Estimate the dry matter yield per acre of the forage crop you want to use for hay or silage making. The amount of dry matter calculated under “f” divided by this dry matter yield determines the acreage to be grown.



2.5. Describing feeding strategies of dairy cattle

Formulating rations provides cows with the nutrients they need to stay healthy and optimize production.

- The basis of a cow's diet should be high-quality forage.
- Acid neutral detergent fibre should be at least 18 per cent and neutral detergent fibre at least 28 per cent of ration dry matter.
- Balance rations to meet the nutrient requirements for each stage of lactation.
- Added fat shouldn't go above 7 per cent of ration dry matter.
- Include vitamins and minerals to meet the cow's needs.

The ruminant feed pyramid provides the basis for formulating rations.

- High-quality forages and grains are the base of all diets and will support good milk production.
- Added fats, rumen undegradable protein and other feed additives are needed by higher producing cows.

The goal of feeding program should be:

- To meet the cows nutritional needs while maintaining health.
- To optimize milk production, milk fat and milk protein.
- Accomplished economically.

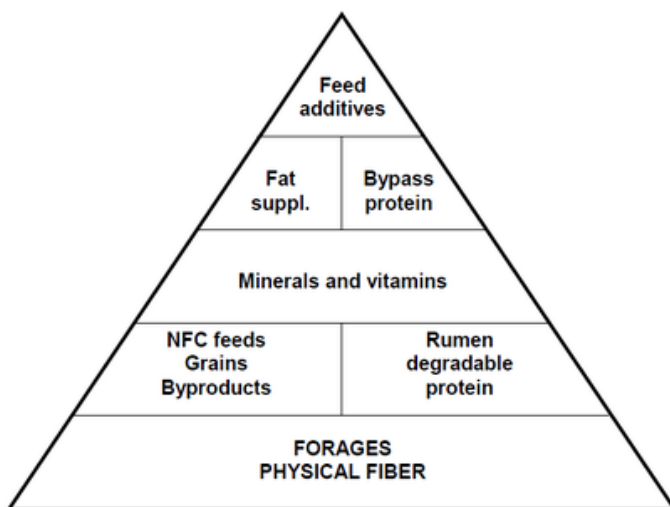


Diagram 2.3 dairy animal feeding strategy pyramids

It is recommended that the practitioner utilize a ration balancing program to meet the described requirements and recommendations.

A. Diet balancing

In the Ethiopia, it is common to have different types of feeding situations. Small dairy farms may have their herds tied up in tie-stall barns and feed the cow's individual ingredients (forage, grain, and supplement). This is referred to as component feeding while laborious it provides for individualized feeding. In larger facilities, it is common to place cows in various groups by performance,

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reproductive status, or by parity. For example, cows could be separated into a high production group, medium production group, and a low production group based on milk yield. Or cows could be grouped by reproductive status so that most non-pregnant cows are grouped together. Also, it is common to have young, first-calf cows in a separate pen as older cows can be aggressive to the young cows and limit their time at the feed bunk.

B. Bunk space

Dairy cows need two feet of bunk space for adequate dry matter intake. This is commonly found in two-row barns (two rows of free-stalls) that are not overcrowded. Three-row barns are also common but reduce bunk space by six inches. It is now recommended that these barns have headlocks or some means of allowing the cow “space”. Open areas with rails or cables do not provide for cows to be able to eat as cows are hierarchical animals and a boss cow can control a large part of the bunk. Allowing cow’s access to feed through headlocks decreases this effect.

C. Water

Water is the most important nutrient and cows need clean, fresh water free of stray voltage or anything that decreases intake (off flavors). To provide for optimal water intake cows need about four inches of water space per head. Waterers should be cleaned routinely, some high producing herds clean that waterers at every milking.

D. Cow comfort

Since the thermal neutral zone for exotic cattle ranges from 5 to 20°C, it is a necessity for some type of heat abatement. Fans and misters are common in hot environments, these cool the cows and improve air quality optimizing intake and reduce internal cow heat build-up.

Adequate cow stalls are also important; cows need to be able to lay down for 14 h per day to optimize performance. Providing clean dry stalls is imperative for enhanced milk production.

E. Consistency

Dairy cattle do not like change. Feeding at the same time and milking at the same time will enhance performance in the herd. Decreasing time away from feed and water (reduced time in the holding areas) will enhance performance. It is recommended that water be available in holding areas to decrease time away from waterers.

F. Feeding

While it is common to feed once daily, more producers are now feeding at least twice daily. Some producers with high yielding cows feed four times per day. Because cows like consistency, the more a producer feeds, the more likely the cows will eat. It is common to push up feed to stimulate intake.



Pushing up feed at least six times a day is recommended. Some automatic feed pushers work 12 h per day.

Intake

There are three theories describing feed intake by cattle. The first theory is bulk, as NDF in the diet increases, feed intake decreases due to stretch receptors in the rumen wall signaling satiety. The second is based on energy intake. Diets based on high-energy will result in reduced intake when the energy requirement is met. This theory will only work in late lactation and during the dry period when cows can eat to meet caloric requirements. The third theory and the one most likely observed is the oxygen consumption theory. As cows produce more milk, the need for the blood to carry oxygen to tissues is increased, and the heart must pump at a faster rate and consumption of oxygen increases. More nutrients are provided to the mammary gland resulting in a greater need for nutrient uptake and hence greater feed intake.

G. Dry cow feeding

The lactation cycle of a dairy cow includes a dry or non-lactating phase. The typical lactation lasts 305 days and during this time the cow should get pregnant usually between 60 and 90 days but before 100 days. The dry period typically lasts 60 days during this period the calf is growing and the mammary gland undergoes involution. The diet is typically a high forage diet and beginning about 3–5 weeks before the cow is expected to calve, the diet is changed to a higher concentrate diet. This serves several purposes including providing more nutrients to the growing calf and the cow as dry matter intake begins to drop as the cow approaches parturition. Also, the rumen micro biota need to change to reflect the diet fed after parturition. This change in diet also causes the rumen papillae to lengthen resulting in more surface area for nutrient absorption. This can help reduce post calving metabolic disorders such as lactic acidosis and ketosis. These cows are typically fed a negative DCAD (mEq/kg) diet to reduce the chance of hypocalcaemia post-calving. Jersey cows seem to be more prone to hypocalcaemia than other breeds.

2.6.Undertake and record dairy cattle body condition scoring

Body condition is a reflection of the body fat reserves carried by the animal. These reserves can be used by the cow in periods when she is unable to eat enough to satisfy her energy needs. In high producing cows, this normally happens during early lactation, but it may also happen when cows get sick, are fed poor quality feeds, or feed intake is restricted. After a period of weight loss, cows should be fed more than their requirements to restore normal body condition.

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Cows should be scored by both looking at and handling the backbone, loin and rump areas. Since the pin bone, hip bone, top of the backbone and ends of the short ribs do not have muscle tissue covering them, any covering you see or feel is the combination of skin and fat deposits.

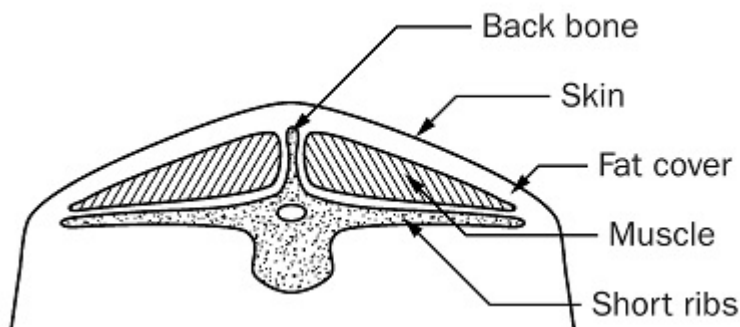


Figure 2.4 bone and muscular structure of dairy animal

Cows should be scored regularly to reflect changes in fat reserves in each stage of lactation. Ideally, all cows should be scored at the beginning and end of their dry period and at least 4 or 5 times during lactation. Scores should be evaluated based on stage of lactation (days in milk or days dry).

With practice, "hands-on" scoring of the herd takes only 10–15 seconds per cow and provides a wealth of information. To monitor the results of your feeding and management program, put a regular body condition scoring routine to work in your herd.

Figure 5 Condition score 1 (thin-yellow zone)

This cow is emaciated. The ends of the short ribs are sharp to the touch and together give a prominent shelf-like appearance to the loin. The individual vertebrae (spinous processes) of the backbone are prominent. The hook and pin bones are sharply defined. The thurl region and thighs are sunken and in-curving. The anal area has receded and the vulva appears prominent.



Figure 2.5 Dairy herd body condition score 1

Condition score 2 (Average - Green Zone)

This cow is thin. The ends of the short ribs can be felt but they and the individual vertebrae are less visibly prominent. The short ribs do not form as obvious an overhang or shelf effect. The hook and pin



bones are prominent but the depression of the thurl region between them is less severe. The area around the anus is less sunken and the vulva less prominent.



Figure 2.6 Dairy herd body condition score 2

Condition score 3 (heavy-yellow zone)

A cow in average body condition. The short ribs can be felt by applying slight pressure. The overhanging shelf like appearance of these bones is gone. The backbone is a rounded ridge, and hook and pin bones are round and smoothed over. The anal area is filled out but there is no evidence of fat deposit.



Figure 2.7 Dairy herd body condition score 3

Condition score 4 (heavy-yellow zone)

A cow in heavy condition. Individual short ribs can be felt only when firm pressure is applied. Together they are rounded over with no shelf effect. The ridge of the backbone is flattening over the loin and rump areas and rounded over the chine. The hook bones are smoothed over and the span between the hook bones over the backbone is flat. Area around the pin bones is beginning to show patches of fat deposit.



Figure 2.8 Dairy herd body condition score 4

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Condition score 5 (fat-red zone)

A fat cow. The bone structure of the topline, hook and pin bones and the short ribs is not visible. Fat deposits around the tailbone and over the ribs are obvious. The thighs curve out, the brisket and flanks are heavy and the chine very round.



Figure 2.9 Dairy herd body condition score 5

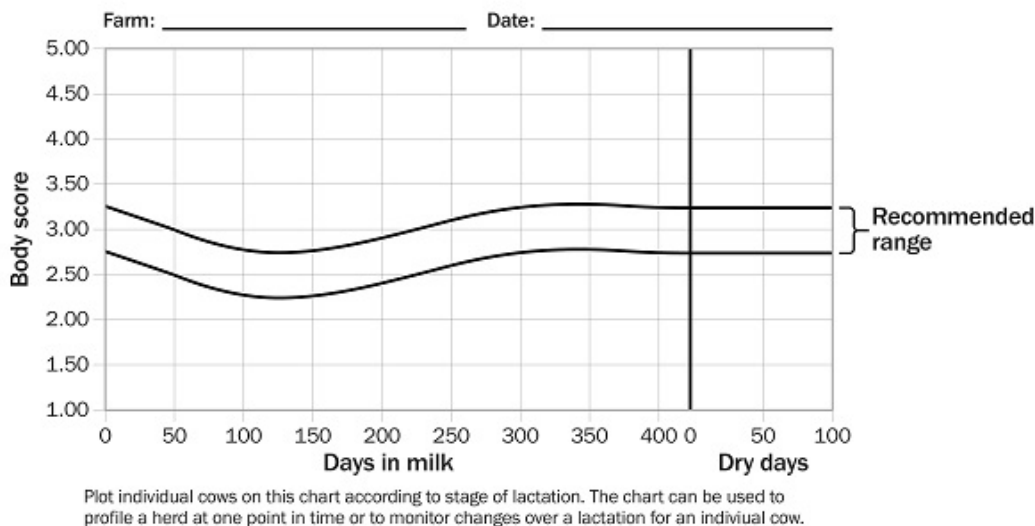


Diagram 2.4 Dairy herd body condition score chart

2.7. Identifying, selecting and preparing facilities and equipment






2.7.1. Dairy equipment

For easy production of dairy animals certain equipment has been designed and are used to facilitate management operation. In dairy animals, this equipment appears to be common and work with the same principle. Virtually all of this equipment are imported but could also be fabricated locally.







During working any dairy animals husbandry management activities the suitable materials, tools and equipment should be identify. These identified materials, tools and equipment should also be checked the functionality and then use properly. After identifying all the required materials know the operation and maintenance system or check the present condition of tools improve / maintain if necessary.









Table 2.3 Equipment of dairy farm

Equipment	Function	Sample Picture
Weighing scale	This is used to know or measure the weight of the animals, feed and materials	
Tractor	Compact tractors are ideal for heavy duty landscaping and tasks such as digging, hauling or plowing in large gardens, fields and pastures.	
Strip Cup	A strip cup is a very useful tool and a must for all dairy farmers. Milking the first few strips into a strip cup will show if there are any lumps present indicating beginning or advanced mastitis, which should be controlled urgently.	
Thermometer	A thermometer is very useful to check body temperature. It is an essential tool for the serious livestock farmer to help her or him in judging animal health.	
Boling gun	It is used for oral administration of solid drugs.	









Burdizzo Castrator	This is used to castrate unwanted males on the farm. Castration is the act of making a male animal impotent by open or a surgical removal of its scrotum.	
Elastrator	It is a bloodless castrator that use the ring method	
Drenching Gun	This is made of a long tube or rubber hose long enough to enter the mouth of ruminants. It is used for oral administration of liquid drug especially during de-worming exercise	
Tattoo pliers	The needles pierce the skin to make clear and readable marks. Black tattoo ink is used for normal use and green tattoo ink for animals with a black or darkly pigmented skin.	
Hooves Trimmer	Used to trim or remove animal hooves.	
Dehorning saw	Used to cut the horn of animal	



Dehorning wire	Used to cut the horn of animal	
Crush	Used to restrain animal	
Ear tags	<i>Ear tag</i> is a plastic or metal object used for identification of domestic livestock and other animals. Flexible plastic tags are probably the most widely used for animal identification, as they are readable from a distance.	
Ear tag applicator	Used for fixing ear tag to the ear of the animal for identification.	
Bull holder/ nose lead	The cattle nose lead cow ring holder is a bull head fixation device. It can be used to spread the attention of cattle by simply clamping it on both sides of the nasal septum.	
Branding iron	A <i>branding iron</i> is used for <i>branding</i> , pressing a heated metal shape against an object or livestock with the intention of leaving an identifying mark.	



Shovel	A shovel is a tool for digging, lifting, and moving bulk materials, such as soil, coal, gravel, snow, sand, or ore. Most shovels are hand tools consisting of a broad blade fixed to a medium-length handle.	
Wheel barrow	A wheelbarrow is a small hand-propelled vehicle, usually with just one wheel , designed to distribute the weight of its load between the wheel and the operator.	
Mineral boxes	Used to store minerals	
Waterier	Is a man-made or natural receptacle intended to provide drinking water to animals, livestock on farms or ranches or wild animals	
Feeding trough	Is a man-made intended to provide feed for animals	
Milking pails/can	Used as storage or continuer of milk.	



Fork	Used to collect waste	
Nipple Feeders	For feeding young cattle with milk replacers	
Spade	Used to digging and loosing soil	
Automatic Syringes	Used to provide vaccine drugs for large numbers of animals.	

2.7.2. Dairy housing and facilities

Dairy animals house should be so constructed and situated in relation to feed storages, hay stacks, silo and manure pits as to affect the most efficient utilization of labour. Sufficient space per cow and well-arranged feeding mangers and resting are contributing not only to greater milk yield of cows and make the work of the operator easier also minimizes feed expenses. The relative position of the feed stores should be quite adjacent to the cattle barn.

Note: Worthy features of feed stores are given:

- Feed storages should be located at hand near the center of the cow barn.
- Milk-house should be located almost at the center of the barn.
- Centre cross-alley should be well designed with reference to feed storage, the stall area and the milk house.



A. Types of housing

Dairy cattle may be successfully housed under a wide variety of conditions, ranging from close confinement to little restrictions except at milking time. However, **two types** of dairy barns are in general use at the present time.

- The loose housing barn in combination with some type of milking barn or parlor.
- The conventional dairy barn.

i. Loose Housing

- It is a system of housing in which animals are kept loose in an open paddock throughout the day and night except at the time of milking and treatment.
- In this system, shelter is provided along one side of open paddock under which animals can retire when it is very hot or cold or during rains.
- Common feed manger and water tank is provided and concentrates are fed at the milking time which is done in a separate milking barn or parlour in which cows are secured at milking time and are milked.
- The open paddock is enclosed by means of half walls or plain wire fences of convenient height.



Figure 2.10 Loose dairy cattle house



Advantages

- Cost of construction is cheaper.
- Future expansion is possible.
- The animals will move freely so that it will get sufficient exercise.
- The animal can be kept clean.
- Common feeding and watering arrangement is possible.
- Clean milk production is possible because the animals are milked in a separate milking barn and Estrus detection is easy.

Disadvantages

- It is not suitable for temperate Himalayan region and heavy rainfall areas.
- It requires more floor space.
- There is competition for feed.
- Attention of individual animal is not possible.
- A separate milking barn is needed for milking of animals.

ii. Conventional Barns or Stanchion Barns

- In this system of housing, the animals are confined together on a platform and secured at neck by stanchions or neck chain.
- The animals are fed as well as milked in the same barn.
- These barns are completely covered with roofs and the sidewalls are closed with windows or ventilator located at suitable places to get more ventilation and lighting.
- It is applicable for temperate and heavy rainfall region.
- The same type of housing can be utilized for tropical region with slight modification.



Figure 2.11 Conventional dairy cattle house

Advantages

- The animals and men caring for animals are less exposed to harsh environment.
- The animals can be kept clean.
- Diseases are better controlled.
- Individual care can be given.
- Separate milking barn is not required.

Disadvantages

- Cost of construction is more.
- Future expansion is difficult.
- Not suitable for hot and humid climatic conditions

B. The house animal shed should have the following parts:

- Feeding passage
- Manger
- Standing space
- Gutter or drainage channel
- Milking passage

The house animals can be housed according to number of animals available.

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Single row system: In single row system, 12-16 numbers of animals can be kept.

Double row system

- If it is greater than 16, then double row system is preferable.
- In double row system up to 50 animals can be maintained in a single shed.
- The distance between two sheds should be greater than 30 feet or it should be twice the height of the building.

C. In double row system two methods available. They are:

a) Tail to tail system (out-method)

Advantages

- Cleaning and milking of animals easy.
- Supervision of milking also easy.
- Less chance for transmission of diseases from animal to animal.
- Animals can get more fresh air from outside.



Figure 2.6 tail to tail arrangements

b) Head to head system (in-method)

Advantages

- Getting animals into the shed is easy.
- Feeding of animals also easy.
- Disinfection of gutter will be more due to the direct fall of sunrays over the gutter.
- Animals are better exhibited to visitors

Disadvantages

- Milking supervision is difficult
- Possibilities of transmission of disease is high

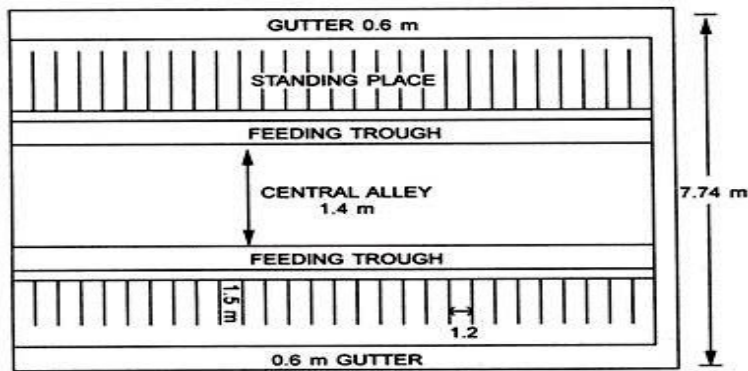


Diagram 2.5 face to face arrangements

2.8. Performing new born animals management practices

There are well ‘tried and tested’ procedures for managing newborn calves. These include:

- Making sure the calf is breathing by clearing the nose and mouth. If breathing is slow to occur, stick a piece of straw up the nose to stimulate breathing and if this fails then pour cold water over the calf’s head, especially into its ear canal.
- Removing the calf from any contaminated bedding by providing clean bedding where the dam can lick the calf.
- Placing the calf into a dog sitting position to encourage breathing and disinfect the navel cord with 7% iodine solution at least once.
- The next steps can be summarized in three statements: Get her up, get her dry and get her fed.
 - Get her up. Encourage the calf to stand.
 - Get her dry. Allow the dam to lick the calf and/or vigorously rub the calf with a dry towel to create a dry fluffy coat.
 - Get her fed. Assist the calf to suckle from a clean teat so it can immediately drink colostrum.
- Minimize the possibility of pathogens entering the calf via two major routes, namely the mouth and the navel.
- Permanently identify each calf
- Calves born from difficult calving’s should be clearly marked to closely watch over the next few weeks

In summary, for a normal delivery, a newborn calf should exhibit the following signs:

- The calf tries to lift its head within minutes.
- It rolls up on its sternum within 5 min.
- It attempts to stand within 15 min.
- It is standing within 1 hr.



- It suckles within 2 hr.

If calves do not exhibit these signs, chances are that the delivery is not normal and the calf requires assistance.

2.8.1. Managing the milk-fed calf

There is no single best way to milk-rear calves. All sorts of combinations of feeding, housing and husbandry can be successful in the right hands and on the right farm.

The essence of good calf rearing depends on two major nutritional factors:

- An adequate intake of high quality colostrum within the first day of life and
- Feeding management to encourage early rumen development.

I. Colostrum feeding

Calves are born with no immunity against disease. Until they can develop their own natural ability to resist disease, through exposure to the disease organisms in their surroundings, they depend entirely on the passive immunity acquired by drinking colostrum from their dam.

Colostrum is the thick, creamy yellow, sticky milk first produced by cows initially following calving, and contains the antibodies necessary to transfer immunity to their calves. It is essentially milk reinforced with blood proteins and vitamins. It has more than twice the level of total solids than whole milk through boosted levels of protein and electrolytes. It also contains a chemical allowing newborn calves to utilize their own fat reserves to immediately provide additional energy.

The chances of calves surviving the first few weeks of life are greatly reduced if they do not ingest and absorb these antibodies into their bloodstream. It takes far fewer disease organisms to cause disease outbreaks in such calves than if they can acquire immunity from their dam. Calves without adequate passive immunity are four times more likely to die and twice as likely to suffer disease, than those with it.

Furthermore, in certain situations, blood levels of antibodies in heifer calves are directly related to their milk production in later life.

There are three key principles for colostrum feeding which can be summarized as the three Qs, namely:

- Quality: Only provide good quality colostrum.
- Quantity: Ensure calves ingest sufficient antibodies.
- Quickly: The timing of the first feed must ensure efficient absorption of the antibodies into the blood.

In summary, the important principles of good colostrum management are:

- Use colostrum from mature cows that produce less than 8 L at their first milking.
- Use only first milking colostrum, do not sterilize it but ensure the feeding equipment is clean and has been sterilized.

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- Feed 4L to large calves or 3 L to smaller calves at first feeding.
- Feed colostrum as soon as possible, at least within the first 3 hr after birth
- Do not let calves suckle their dams

II. Feeding milk to the calves

Calves require a diet of good quality whole milk or calf milk replacer (CMR). The choice of liquid feed should be based on its cost per litre and this depends on the milk returns for raw milk and the cost of the CMR powder. In many cases, CMR is the cheaper when diluted to a mixture of one part CMR and 10 parts water (or as per the manufacturer's recommendations). The CMR must be a good quality product to ensure calves can digest it properly.

Milk can be fed either through teats or directly from a bucket. There is no difference in the ability of the calf to utilize the milk fed either way (Moran 2012b).

If calves are sucking each other, teat feeding may be necessary to control this. Milk can be fed once or twice a day as it clots in the calf's stomach after which it is slowly broken down by the calf's gastric juices. The milk does not have to be heated up before feeding. It is important that the milk concentration, timing and temperature remain consistent from day to day. Calves should be given free access to good quality drinking water from 1 week of age.

It is very important that calves are kept in clean pens and that hot water is available to clean milk-feeding equipment. One major health problem is scours, which results mainly from an inconsistent milk feeding program, poor hygiene and inadequate colostrum feeding. As many scours are not due to bacterial diseases, there is often little need to consider antibiotics in the treatment. Fluids and electrolyte replacement are the main requirements.

2.9.Performing heifers management practices

Weaned growing heifers require less attention than milk-fed calves and milking cows. From weaning until breeding and sometimes even after then, daily contact is not necessary. Because their nutrient requirements are relatively low compared to milking cows, heifers may be located away from the dairy farm, sometimes on adjustment on other farms. Unfortunately, the saying 'out of sight, out of mind' applies too frequently to replacement heifers. This relative neglect is understandable in view of the long time it takes before any inadequacies in post-weaning practices are reflected in poor milking cow performance.

Dairy heifers need to be well fed between weaning and first calving. Growth rates should be maintained, otherwise heifers will not reach their target live weights for mating and first calving.

Undersized heifers:

- Have more calving difficulties
- Produce less milk

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- Have greater difficulty getting back into calf during their first lactation
- When lactating, they compete poorly with older cows for feed
- Because they are still growing, they will use some of their feed for growth rather than for producing milk
- They are more likely to be culled for poor milk yield and/or infertility.

The onset of puberty is related to weight rather than age. A delay in puberty means a later conception, which can disrupt future calving patterns and increase rearing costs. All heifers should reach a minimum weight before joining, as lighter heifers have lower conception rates. Target growth rates should be 0.6 to 0.7 kg/head/day.

Although replacement heifers are essentially non-productive animals, some expenditure is necessary. They represent capital and investment in the dairy herd's future. Heifer rearing should achieve the maximum return on this investment with a minimum of outlay. It should not be regarded as a haphazard undertaking, which hopefully will produce a pregnant heifer, but rather as a business enterprise with clearly defined goals such as:

- The number of animals to be reared
- Their desired age at first calving
- Their target live weight at calving
- Their feeding program
- Ways to monitor their performance and total rearing costs
- Any specific housing and health requirements.

When rearing dairy replacement heifers, producers should have five major objectives:

- **The maintenance or expansion of herd size**

Heifer rearing systems should provide sufficient animals to replace cows culled from the milking herd and allow for increases in herd numbers if required.

- **Calving by 24 to 30 months of age**

Entry into first lactation by 24 months of age minimizes the total non-productive days and maximizes lifetime productivity.

- **Sufficient growth for minimal dystocia (that is calving difficulties) at first calving**

Heifers need to be large enough to calve without difficulty.

- **Maintenance of health**

The prevention of clinical and subclinical disease plays a large role in the ability of replacement heifers to meet live weight and age targets at first calving. Longevity and lifetime productivity is also affected.

- **Genetic progress**

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Replacement heifers generally have higher genetic merit than the current milking herd. This can be expressed as increased productivity (both milk volume and solids), improved efficiency of production and/or enhanced resistance to disease.

Heifer rearing is not cheap and the costs to produce a lactating first-calf heifer can account for 15 to 20% of the total milk production costs. It is not good economics to cut back on heifer-rearing costs as lifetime profits will be reduced.

The costs of heifer rearing are discussed in Chapter 11 at Section 11.4.3.

The number of first calving heifers each year will depend on the replacement rate within the milking herd. This is the sum of the wastage rate caused by infertility, lameness, mastitis, low milk yield, old age, accidents etc., together with the particular voluntary culling policy for that herd, whether this is to improve milk yield, feed efficiency or reduce calving interval. The number of heifer replacements to be reared also depends on mortality rates during rearing, the conception rates at first mating and the proportion of heifers reaching target weight for ages.

With two to three heifers per 10 cows introduced into the milking herd annually, at least 80% of the milking cows should be mated (either using a bull or artificially insemination) to obtain that number of replacements each year. When determining the total number of calves to rear, consideration could be given to rearing additional heifers for sale to other dairy farmers and/or bull calves for dairy beef.

On well-managed farms in temperate dairy regions, achieving a consistent calving program, requires heifers to:

- Reach puberty at ~12 months of age
- Become pregnant at 14 or 15 months of age
- Calve at 24 months of age
- Return to estrus and be mated within 70 to 80 days of calving

2.9.1. Feeding heifers to achieve target live weights

Producers should regularly weigh or monitor their young stock, and then vary feeding strategies according to their growth rates. Growth in Friesians should average 0.6 to 0.7 kg/day, although that can vary between 0.5 and 1.0 kg/day, depending on available forage and the supply and cost of suitable supplements.

As fresh forage is the cheapest feed, it should constitute the bulk of the diet, with silage or hay and concentrates used to overcome forage shortages. Until calves reach 200 kg in weight, they are not able to maintain the growth rates needed to reach target weights on diets of most forage. Their capacity is limited and they simply cannot eat enough forage to meet their nutrient requirements for rapid growth.

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Forage quality and allocation should allow for continuous growth throughout the first two years. Uniform growth is not necessary and may be impracticable with seasonality of quality forage supplies. However, heifers should not be allowed to lose weight or to grow very slowly for long periods of time.

2.10. Performing lactating, pregnant and dry cow management practices

2.10.1. Feeding of lactating cows

Proper feeding of dairy cattle should envisage minimum wastage of nutrients and maximum returns in respect of milk produced. The general principles of feeding are similar in cattle and buffaloes.

The ration is a 24-hour allowance of a feed for an animal. It includes maintenance and production allowances. The maintenance ration is based primarily on body weight of the animal.

The approximate body weight of a cow can be estimated from body measurement using the following equation.

- **Body weight (kg)** = $3.3 (\text{chest girth in cm}) + \text{posterior girth in cm} + 0.7(\text{length in cm}) - 490$ Chest girth is the circumference around the chest just behind the withers. Posterior girth is the circumference around the belly. Length is measured from point of shoulder to the pin bone.
- **Body weight (lbs.)** = $LG^2/300$ where body length (L) and girth (G) are measured in inches. To convert into kg this may be divided by 2.2.

The production ration is based on milk yield and its fat content and is dependent on whether the cows are pregnant and or still growing.

Table 2.4 Feeding schedule for different classes of adult cows

When green grass is plenty			When paddy straw is the major roughage		
	Concentrate mixture (kg)	Green grass (kg)	Concentrate mixture (kg)	Green grass (kg)	Paddy straw (kg)
Dry cows	--	25-30	1.25	5.0	5-6
Milking	1 kg for every 2.5-3.0 kg of milk	30	1.25+1 kg for every 2.5-3.0 kg of milk	5.0	5-6
Pregnant	Production allowance+ 1 to 1.5 kg from 6 th month of pregnancy	25-30	Maintenance + production+ 1 to 1.5 kg from 6 th month of pregnancy	5.0	5-6

Good quality roughage should form the basis for economic milk production .The amount and protein content of concentrate Mixture can be decided by the quality of roughage provided .Good quality gasses (Guinea, Napier etc) with a minimum of 6 % crude protein on dry matter basis alone can form



maintenance ration of a cow of average size. But it is possible to maintain milk production of up to 3-4 kg with grass-legume fodder

Even good quality roughage alone cannot entirely replace concentrates in the case of high yielders. Straw can form the roughage in the absence of grasses and in such cases concentrates should be given for maintenance. If straw forms the sole roughage, vitamin A should be supplemented in the concentrate mixture at the rate of at least 5000 I.U. per kg of the mixture. Any vitamin A preparation available in the market can be used. If at least 5 kg of green grass is provided vitamin A supplemented is not necessary.

For lactating cows, 1 kg of concentrate mixture (compounded feed) (0.14-0.16 kg DCP and 0.70 kg TDN) may be required for every 2.5-3.0 kg milk over and above the maintenance allowance. After parturition, the cow should be given the same type of feed and the same quantity as before and the concentrate allowance should only gradually increased to avoid digestive troubles like acidosis, indigestion, etc.

In the case of young cross-breed cows below four years old age to meet the needs for growth, it is desirable to give additional concentrate allowance at the rate of 1 kg for animals in first lactation and 0.5 kg in the second lactation over and above the maintenance and production needs. Milking animals should always have free access to clean fresh drinking water.

Tips for feeding of dairy cattle:

- A. Concentrate must be fed individually according to the production requirements
- B. Good quality roughage saves concentrates. Approximately 20 kg of grasses (Guinea, Napier, etc) or 6-8 kg legume fodder (cowpea, Lucerne) can replace 1 kg concentrate mixture (0.14-0.16 kg DCP) in terms of protein content.
- C. 1 kg straw can replace 4-5 kg of grasses on dry matter basis. In this case the deficiency of protein and other nutrients should be compensated by a suitable concentrate mixture.
- D. Regularity in feeding should be followed. Concentrate mixture can be fed at or preferably before milking- half in the morning and the other half in the evening- before the two milking. Half the roughage ration can be fed in the forenoon after watering and cleaning the animals. The other half is fed in the evening, after milking and watering. High yielding animals may be fed three times a day (both roughage and concentrate) increasing the frequency of concentrate feeding will help maintain normal rumen motility and optimum milk fat levels.
- E. Over-feeding concentrates may result in off feed and indigestion.
- F. Abrupt change in the feed should be avoided
- G. Grains should be ground to medium degree of fineness before being fed to cattle.
- H. Long and thick stemmed fodders such Napier may be chopped and fed.



- I. Highly moist and tender grasses may be wilted or mixed with straw before feeding legume fodders may be mixed with straw or other grasses to prevent the occurrence of bloat and indigestion.
- J. Silage and other feeds which may impart flavor to milk may be fed after milking.
- K. Concentrate mixture in the form of mash maybe moistened with water and fed immediately. Pellets can be fad as such.
- L. All feeds must be stored properly in well ventilated and dry places. Moldy or otherwise damaged feed should not be fed.
- M. For high yielding animals, the optimum concentrate roughage ratio on dry matter basis should be 60:40.

2.10.2. Feeding of dry and pregnant cows

For dry cow's maintenance allowances as per the feeding schedule alone need be given. The ration for pregnant animal should be adequate for development of the estrus as well as for providing nutrient reserves to maintain milk production.

Heavy milk production is a severe drain from the body and therefore the cow should be allowed a dry period of two months before the next calving. A good cow in good condition at the time of parturition will provide more milk and reach the peak production much earlier.

Better feeding during the later stages of pregnancy is also important since the body condition at the time of calving influences the postpartum reproductive efficiency.

A pregnant animal should be given 1-1.5 kg of concentrate mixture over and above the maintenance and production allowance from the 6th month of pregnancy. A drastic reduction in the concentrate allowance of the pregnant animals may lead to metabolic disorders like ketosis during the next lactation period. Rations for pregnant cows should contain higher levels of Vitamin A. Excessive amounts of calcium should be avoided to reduce the incidence of milk fever in high yielding cows.

Laxative feeds may be included in the ration a few days before and after calving. Brans, green grasses etc. are good for this purpose.

2.11. Identifying and maintaining hygiene, health and environmental requirements

2.11.1. Animal health

Good dairy farming practice to ensure animals that produce milk are healthy and there is an effective health care program in place. However, not all of the practices are applicable in all circumstances and may be superseded by national, international or market demands.

The suggested good dairy farming practices for animal health are set out under the following headings:

- Establish the herd with resistance to disease.
- Prevent entry of disease onto the farm.

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- Have an effective herd health management program in place.
- Use all chemicals and veterinary medicines as directed.

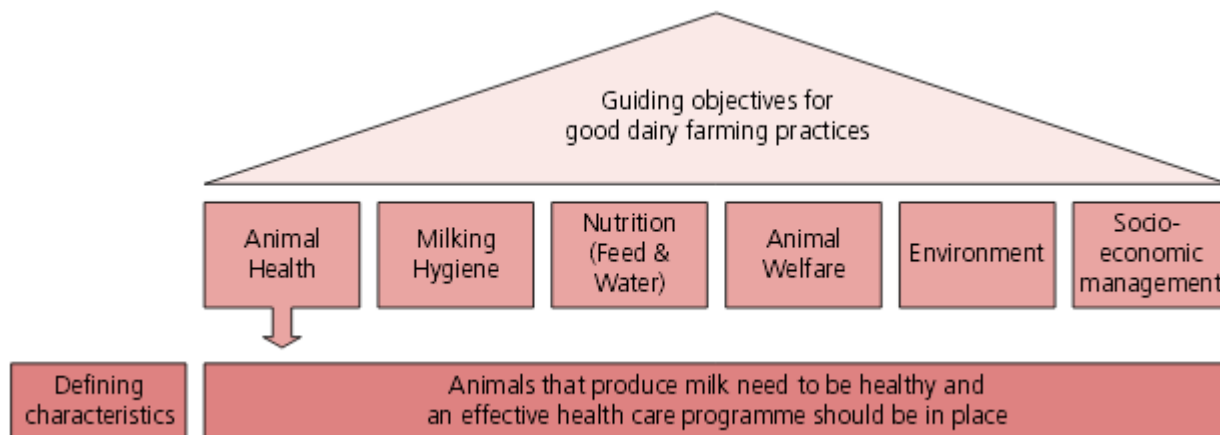


Diagram 2.10 effective dairy health care programs

Table 2.5 effective dairy health care program

Good dairy farming practice	Examples of suggested measures to achieve good dairy farming practice	Objectives of these measures
Establish the herd with resistance to disease	<ul style="list-style-type: none"> • Choose breeds and animals well suited to the local environment and farming system • Determine herd size and stocking rate based on management skills, local conditions and the availability of land, infrastructure, feed, and other inputs • Vaccinate all animals as recommended or required by local animal health authorities 	<ul style="list-style-type: none"> • Enhance herd disease resistance / reduce stress
Prevent entry of disease onto the farm	<ul style="list-style-type: none"> • Only buy animals of known health status (both herd and individual animals) and control their introduction to the farm using quarantine if indicated • Ensure animal transport on and off the farm does not introduce disease • Monitor risks from adjoining land and neighbours and have secure boundaries • Where possible, limit access of people and 	<ul style="list-style-type: none"> • Maintain farm biosecurity • Keep animals healthy • Comply with international/national/regional animal movement and disease controls



	<p>wildlife to the farm</p> <ul style="list-style-type: none"> • Have a vermin control program in place • Only use clean equipment from a known source 	
Have an effective herd health management program in place	<ul style="list-style-type: none"> • Use an identification system that allows all animals to be identified individually from birth to death • Develop an effective herd health management program focused on prevention that meets farm needs as well as regional and national requirements • Regularly check animals for signs of disease • Sick animals should be attended to quickly and in an appropriate way • Keep sick animals isolated • Separate milk from sick animals and animals under treatment • Keep written records of all treatments and identify treated animals appropriately • Manage animal diseases that can affect public health (zoonoses) 	<ul style="list-style-type: none"> • Detect animal diseases early • Prevent spread of disease among animals • Ensure food safety • Ensure traceability
Use all chemicals and veterinary medicines as directed	<ul style="list-style-type: none"> • Only use chemicals approved for supply and use under relevant legislation • Use chemicals according to directions, calculate dosages carefully and observe appropriate withholding periods • Only use veterinary medicines as prescribed by veterinarians • Store chemicals and veterinary medicines securely and dispose of them responsibly 	<ul style="list-style-type: none"> • Prevent occurrence of chemical residues in milk



2.11.2. Hygiene

I. Ensure housing environment is clean at all times

A high standard of cleanliness should be maintained at all times in housing areas to decrease soiling of the udder and so protect udder health. The housing area should:

- Be designed to provide good drainage and ventilation and to avoid animal injury;
- Be of suitable size and designed to cater for the size of the animal and the herd; and
- Have adequate loose bedding which is maintained in a hygienic condition.

All stalls and beds should be kept clean and dry (e.g. by replacing the bedding frequently). Regularly clean or scrape passageways to remove manure

II. Ensure facilities are kept clean

The house should be designed to allow it to be kept clean and tidy. It should:

- Be easy to clean;
- Have a clean water supply;
- Have waste handling facilities; and
- Have sufficient temperature regulation, ventilation and light.

Construct holding yards to enable a high standard of cleanliness to be maintained.

2.11.3. Environment

Increasingly, consumers are concerned that the production of food is sustainable and is undertaken in harmony with the environment. To meet these concerns it is important that dairy farmers produce milk in a way that meets the wider community's expectations, by using natural resources efficiently and minimizing any adverse impact on the environment.

Every dairy farmer can play a role in protecting their industry and the future of their enterprise by adopting management practices that enhance the environmental sustainability of their farming system.

The suggested good dairy farming practices for the environment are set out under the following headings:

- Implement an environmentally sustainable farming system.
- Have an appropriate waste management system.
- Ensure dairy farming practices do not have an adverse impact on the local environment

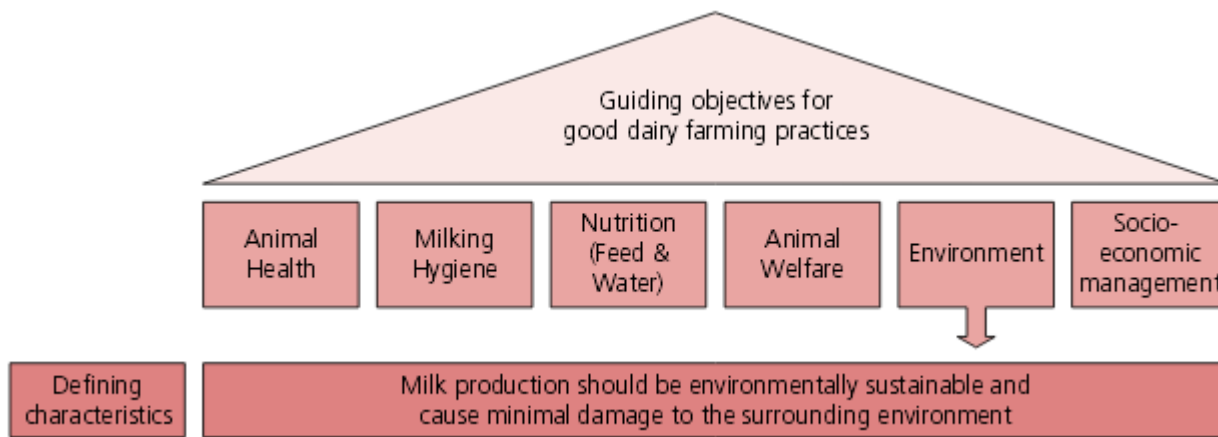


Diagram 2.11 environmental sustainability

Table 2.6 environmental sustainability

Good dairy farming practice	Examples of suggested measures to achieve good dairy farming practice	Objectives of these measures
Secure feed and water supplies from sustainable sources	<ul style="list-style-type: none"> Plan ahead to ensure that the herd's feed and water requirements are met Implement sustainable nutrient, irrigation and pest management practices when growing feed Source farm inputs from suppliers implementing sustainable systems 	<ul style="list-style-type: none"> Provide the herd with adequate feed and water Limit the potential impact of dairy feed production on the environment
Ensure animal feed and water are of suitable quantity and quality	<ul style="list-style-type: none"> Ensure the nutritional needs of animals are met Ensure the feed fed to dairy animals is fit for purpose and will not negatively impact the quality or safety of their milk or meat Ensure suitable quality water is provided and the supply is regularly checked and maintained Use different equipment for handling chemicals and feed stuffs Ensure chemicals are used appropriately on pastures and forage crops and observe withholding periods Only use approved chemicals for 	<ul style="list-style-type: none"> Keeping animals healthy with good quality feed Preserve water supplies and animal feed materials from chemical contamination Avoid chemical contamination due to farming practices



	treatment of animal feeds or components of animal feeds and observe withholding periods	
Control storage conditions of feed	<ul style="list-style-type: none"> • Separate feeds intended for different species • Ensure appropriate storage conditions to avoid feed spoilage or contamination • Reject moldy or sub-standard feed 	<ul style="list-style-type: none"> • Prevent microbiological or toxin contamination or unintended use of prohibited feed ingredients or feeds contaminated with chemical preparations • Keeping animals healthy with good quality feed
Ensure the traceability of feedstuffs brought on to the farm	<ul style="list-style-type: none"> • Where possible, source animal feed from suppliers having an approved quality assurance program in place • Keep records of all feed or feed ingredients received on the farm 	<ul style="list-style-type: none"> • Quality of the feeds fed to dairy animals is assured by the supplier or farmer • Prevent the use of feeds that are unsuitable for dairy animals

2.12. Carrying out record keeping

Record keeping is a necessary element of good dairy management. With no written records, farmers have to depend on their memory while making decisions regarding their farm practices. But, memories can become unreliable after a few days, months or years.

Therefore, no matter how good someone's memory is, it has no substitute for having recordings of information on different aspects of the dairy farm.

2.12.1. Importance of dairy farm recording

Dairy farm record keeping has the following importance:-

- Dairy farm records provide the basis for tracking & evaluating performance.
- Provide up to date information for decision making at different level and aspects of the farm.
- Helps in overall better supervision and management of herd.
- Helps in determining the income and expenditure (economics) of dairy farm.
- Helps in estimating the cost of milk production.
- Helps to compare the herd performances in different years
- Helps to identify problems/gaps and setting future goals/directions for the farm.



- Inform farmers about strengths and weaknesses in their farm operation.

2.12.2. Criteria for good record keeping

If records are not to be more troublemakers than they are worth to farmers, they should satisfy the following criteria:

- **Records must be useful:** - Unless data which is being recorded will at some future time be used (turned in to information) in making management decisions, it should not be recorded at all.
- **Records must be kept in such a form that they can be easily converted into information:** - Before keeping a record, the eventual end use must be decided upon so that the form in which the data are recorded will facilitate later analysis and interpretation. Too often, the end use is not considered, and the usefulness of the data is severely impaired.
- **Record keeping systems must be simple:** - Dairy farmers have enough to do without burdening themselves with complex record keeping systems, which are difficult to understand and time consuming to complete, and therefore nearly impossible to delegate to employees.
- **Duplication must be avoided as much as possible:** - Some data may have to be recorded more than once in different forms, but this must be reduced to a minimum.
- **Records must lead to actions being taken:** - Information must lead to quick actions. Unless a record is specifically intended to be used for some future action or in management planning it should not be kept.

These criteria should be followed when an extension officer recommend the different types of recording an individual farmer should maintain.

2.12.3. Types of dairy farm recordings

There are different types of dairy farm recordings. The following list provides the most applicable types of dairy farm recordings at smallholder farmer level in the Ethiopian context:

- Animal Identification/history record
- Breeding Record
- Milk Production record
- Feeding record
- Young stock record
- Health record
- Financial record

a) Animal Identification/history record

Animal identification/history record provides information about major events occurred on individual dairy cattle from birth up to the time it leaves the herd (could be death, sales or any other reason).

What need to be recorded:- Animal identification/history record include – Animal Name or identification number, date of birth/purchase, breed type, calving period (month) for each calving interval, lactation period (days) for each lactation, lactation yield (average per day and total yield), date of drying, calf its sex & identification number, age when culled, date of disposal (sales/death).

b) Breeding Record

The breeding record will help the farmer to improve his/her breeding management by being able to determine such matters as: - the date at which to dry a cow off; knowing when a cow should deliver a calf; highlighting poor insemination or bull services; establishing breeding dates and feeding programs; identifying calf, sire and dams; and determining the date for pregnancy testing.

What need to be recorded :- Breeding record shall include - Animal identification number/ name, birth date, name of sire and dam, heat dates, calving dates, earliest breeding date, service information, pregnancy examination, expected calving date, drying off date and any additional remarks.

Table 2.7 Breeding record format

Owner's name:							
Region:							
Woreda:							
Kebele:							
Dam ID	Dam Breed	Dam birth date	Sire ID	Sire breed	Date of mating	Due date	Remark

c) Milk Production Record

Milk production record captures the individual cow milk yield per day. These records are useful in measuring the performance of the herd and for the economic appraisal of the enterprise.

What need to be recorded: - Milking cow name or ID number, daily milk yield, and start & end lactation period/date

d) Young stock recording



Young stock recording maintains the records key information of replacements (Calf & Heifer) at different period starting from birth.

What need to be recorded: - Young stock recording include calf number, sex of the calf, sire number, dam number, birth weight, weaning weight, service weight, weight at calving, age at weaning, age at first service, age at first calving etc

Table 2.8 Performance record format

Owner's name:															
Region:															
Woreda:															
Kebele:															
Pre - weaning								At weaning							Remark
Calf ID	Birth date	Sex	Dam ID	Dam breed	Sire ID	Sire Breed	Birth Wt. Kg	Weaning date	Weaning wt. Kg	Type of rearing	Weaning group	Weight at marketing	Body condition score (1 – 5)	Calf price (Birr)	

e) Feed & Feeding Record

Two types of records can be kept: The first is about feed production & purchase and the second is about feeding.

Feeding records give information about the amount, type and quality of the feed provided to dairy animals. In addition, type and quantity of on farm feed production and feed purchased from outside sources.

What need to be recorded: - For feed production/purchase – Type of feed, quantity of feed, purchased feed price. For Feeding: - Dairy cattle identification, Feed type, quantity of feed in take (average and total quantity).

Table 2.9 feeding record format

Owner's name:
Region:
Woreda:
Kebele:



No.	Date	Type of feed	Consumption/kg/	Cost /kg	Total cost	Remarks

f) Health Records

Health records provide overall health information about the animals in the herd. With the use of records, veterinarians can gain additional information about the probable causes of ill health in an animal: Vaccination, Dipping spraying, Treatment, De- worming and Postmortem.

Table 2.10 Health record format

Owner's name:							
Region:							
Woreda:							
Kebele:							
No	ID/Name	Date	Major signs	Suspected disease	Treatment Given	Response	Remark

g) Financial Recording

Financial recordings are records of the costs and earnings related to the dairy farming recorded for financial analysis and dairy enterprise appraisal.

What need to be recorded: - Financial records include dairy farm asset, income/revenue, expenditure and sales records.



Self-check 2	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Choose the best answer

- Which volatile fatty acid is responsible for milk fat synthesis in cow?
a. Propionic acid b. acetic acid c. Butyric acid d. None
- The vitamin which helps in coagulation of blood is
a. Vitamin D b. Vitamin K c. Vitamin A d. Vitamin E
- For rapid growth of bacterium in the rumen, the best source of energy is:
a. Starch b. Molasses c. Sugar d. None
- The physiological fuel value for carbohydrate per gram is
a. 9.3KJ b. 2.3 KJ c. 16.27KJ d. 18.27 KJ
- Name the most important role played by the water in the body through blood:
a. Acid base balance b. Excretion c. Ejaculation d. Defecation
- Protein content in fish meal (%):
a. 15 b. 25 c. 35 d. 60
- Sick animals are isolated to:
A. Avoid fights C. Keep clean
B. Treat them well D. Prevent spread of disease
- Extra feeding of pregnant cow should be done after
C. 6 months E. 1 month
D. 3 months F. 20 days
- Udder secretion immediately after calving is called
A. First milk C. Colostrum
B. Special milk D. Calf starter
- Dry matter required by cow of 400 kg body weight should be (per day)
A. 10 kg C. 2.5 kg
B. 20 kg D. 0.5 kg
- Mastitis is a disease of:
A. Udder C. Heart
B. Reproductive organs D. None of these



12. The principal function of 'Vitamin D is to
- A. Maintain bone growth
B. Form Rhodopsin
C. Keep muscles strong
D. Cause urination
13. A teaser bull is maintained to:
- A. Keep herd moving
B. Detect heat
C. Protect weak animals
D. Inseminate cow
14. Desirable body weight of a heifer at first mating should be
- A. 180 kg
B. 250 kg
C. 400 kg
D. 80 kg
15. DCP for maintenance of a cow/1000 kg body weight should be
- A. 0.70 kg
B. 0.24 kg
C. 1.25 kg
D. 2.00 kg
16. Most dairy calves commercial farm are raised
- A. On milk feeding by hand
B. Dam suckling
C. On another cow
D. On butter milk
17. A feed high in energy or protein, low in fibre and highly digestible is:
- A. Roughage
B. Silage
C. Concentrate
D. Hay
18. Minerals that are mainly involved in skeleton formation
- A. Ca, P & Se
B. Ca, P & I
C. Ca, P & Mg
D. Ca, Mg & S
19. Copper and _____ are mutually involved in the formation of hemoglobin
- A. Iron
B. Cobalt
C. Calcium
D. Chromium
20. Big neck disease in cattle is due to the toxicity of
- A. Zinc
B. Manganese
C. Iodine
D. Iron
21. Feeds that have low digestible nutrients and high fiber content is known as;
- A. Concentrates
B. Roughages
C. Crumbles
D. Mash
22. Which nutrient has heat insulating function in the body?
- A. Fats
B. Carbohydrates
C. Proteins
D. None of them
23. Silage is also known as _____
- A. Pickled fodder
B. Preserved fodder
C. Fermented fodder
D. All
24. True stomach of ruminant's digestive system is



- A. Rumen
B. Reticulum
C. Omasum
D. Abomasum
25. Wheat bran and animal fat are feed concentrates that are classified as:
A. Protein concentrates
B. Crop by-products
C. Processing by-products
D. Supplements
26. Which of the following is a macro mineral?
A. Calcium
B. Zinc
C. Iron
D. Cobalt
27. In the feeding of lactating animals the thumb rule is 1 litter milk production needs ____ Kg concentrates to the animal
A. 1
B. 2
C. 3
D. 4
28. Example of Succulent feeds....
A. Hay
B. Crop residues
C. Pastures
D. Cereal grain
29. Which stomach chamber is lined with intersecting ridges that form honeycomb-like projections
A. Reticulum
B. Rumen
C. Omasum
D. Abomasum
30. The globulin in the colostrum's is considered to have
A. Antigen
B. Antibody
C. Both Antigen and Antibody
D. Nor Antigen nor antibody

Test II: Short Answer Questions

1. What is the advantage of house for the animal?
2. Write the points which should be considered before established of dairy cattle house.
3. Discuss the difference between loose and conventional dairy cattle house.
4. What is the importance of record keeping in dairy farm?
5. What are the major types of records in dairy farms?
6. Write the characteristic good data records should have exists.



Operation Sheet-2

2.1. Determining the right combination of soybean (46% CP) and maize (6.7% CP) to create a mixture containing 16% CP By using Pearson square method.

A. Tools and equipment

- Soybean
- Maize
- Calculator
- Pen
- Paper
- Mixer
- Grinder

C. Procedures/Steps/Techniques of artificial insemination

Step 1

- Draw a square with lines connecting the opposite corners.
- Write the desired percent of crude protein (13) in the center of the square.

Step 2

- Write the feeds to be used and their crude protein percent at the left hand corners of the square.

Step 3

- Subtract the smaller number from the larger, along the diagonal lines. Write the differences at the opposite end of the diagonals.
- The difference between the percent protein in the maize and the percent protein in the ration are the parts of soybean needed.
- The difference between the percent protein in the soybean and the percent protein in the ration are the parts of maize needed.

The sum of the numbers on the right equals the difference in the numbers on the left. This fact is used as a check to see if the square is set up correctly.



Lap test-2

Performance Test

Name..... ID.....
Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 50 minutes. The project is expected from each student to do it.

Task-1 Perform feed formulation by using Pearson square method



LG #3

LO #3 Apply Breeding management of dairy cattle

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying common dairy cattle breeds
- Recognizing reproductive organ and mammary gland of dairy cattle
- Carrying out estrus synchronization and heat detection procedures
- Securing and providing mating areas
- Using mating procedures and handling
- Identifying common reproduction index or fertility indicators

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify common dairy cattle breeds
- Recognize reproductive organ and mammary gland of dairy cattle
- Carry out estrus synchronization and heat detection procedures
- Secure and provide mating areas
- Use mating procedures and handling
- Identify common reproduction index or fertility indicators

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”



3.1. Identifying common dairy cattle breeds

3.1.1. Common dairy cattle breeds in Ethiopia

Ethiopia is the home of diversified cattle breeds. This is due to its diversified agro-ecology, topography and nearness to Asia where most domesticated animals in Africa were originated. A breed is a homogenous group of livestock which are phenotypically unique from other groups or subpopulations of the same species. There are 28 indigenous breeds/types of cattle that have been recognized to exist in Ethiopia. These are grouped in to five major cattle types, large and small East African Zebu, Sanga, Zenga (a breed between Sanga and Zenga) and tourine types that are distributed to be found in all agro-ecological zones depending on their merit to a particular production system from arid tropical to afroalpine ecosystems.

However, the genetic distinctiveness among most Ethiopian local cattle breeds, are largely unknown and unidentified. The purity of indigenous cattle breeds is under threat due to crossbreeding, inbreeding, lack of institutional capacities and policies which support the use of imported breeds for crossbreeding purposes.

On the other hand, some authors mentioned that breed improvement programs of Ethiopian indigenous cattle remain too few while the demand of livestock products is continually increasing. Other major constraints that limit cattle production in the country are, shortage of feed, water, diseases treatment and prevention, and poor housing.

Table 3.1 Common dairy cattle breeds in Ethiopia

Breed name	distribution	Purpose of keeping and measurable traits	Phenotypic and genetic characteristic	Current population status	improvement and conservation activity
BoranaCattle	Distributed in the southern rangelands of Ethiopia, around Liben, Mega and Arero plains kept by Borana pastoralists, large East African Zebu type breed	Dual purpose Mainly for milk and meat, best feed converter produces 2.4 litres milk/day, ranges 300-385 kg male and 250-350 kg female	long distance walking ability, drought resistance, reasonable conception, excellent mothering ability, well developed herd instinct, more docile and resistance, heat tolerance, longevity Short horned, mainly white, fawn or brown with darker shading color on the head, neck and shoulders.	Risk with high destocking young and productive bulls before replacing themselves from stock	In-situ conservation and selection with ranch and ex-situ conservation with cryoconservation.
AfarCattle	Maintained by Afar people in eastern and north Ethiopia (Tigray and Wollo)	average daily milk yield 4±1 lts with 271±22 days of lactation length, ranges from 250-375kg	resistant and adapted to the harsh conditions, Large and slender body, small humps and moderate dewlap, Ash-grey, white smooth, red and shiny coat colour	Increases population due to vaccination regardless of recurrent drought	conventionally practiced by farmers
ArsiCattle	large East African Zebu, central highlands of Ethiopia; Arsi, Shewa, Bale, Sidamo and Harar	Dual purpose mainly for work Milk, ranges 149-809 liters and average of 278.04 litres/ lactation period. average mature weight is 236kg	Habituates highland of Ethiopia Small short horns, dominantly black	Unknown	Dilution is very high with exotic breed
HorroCattle	Distributed in HorroGudru of Eastern Welega; also in Western Shewa, and adjoining areas of Illubabora and Shewa, Zenga type	work, Meat and milk, 100-1550 kg per lactation of 3-8 months and also adult male and females have range of 320-480 kg and 210-400 kg respectively	Adaptive in to humid and wetter agricultural area Dominantly brown or reddish brown coat color thin skin; horns moderate but larger than the common zebu	Risk not clearly identified but number is not decreasing currently	Ranches and community breeding activities being carried out
OgadenZebu Cattle	Lowland Zebu under small east African zebu	Milk, meat and work, average Weight of	Adaptive to hot environments, uniform plain	Draught and conflict are	some activities of cryoconservation being

	distributed in the Ogaden area of the Somali region and bordering Eastern Hararghe	248.5kg (female), 285.7kg (male)	white, black shade around face and humped and in most cases polled	dominant threat	carried out
KereyuCattle	Sanga type breed and distributed in the Kereyu area of Eastern Shewa	mainly for milk, dowry and 463.1litres, average body weight of 300.4 kg and 249.9 kg male and female respectively	well adapted to the hot environmental situation straight profile, long thin legs and long horns plain, patchy and spotty	Unknown	conventionally practiced by farmers
Raya	Sanga type, distributed in east of lake Ashange of Tigray region and the bordering areas of Wello	3±1litrs/day with lactation length of 210±17 days and body weight of male and females are 281±41kg, and219±26kg respectively.	Has a trait of adaptive importance for the production system where the breed exists. mainly used for work, meat and milk	Dilution with other indigenous breeds	conventionally practiced by farmers
Sheko	the only hump less short-horned taurine breed in east Africa and it is distributed in the humid parts of south-western Ethiopia around	Milk, meat,work Average milk yield ranges 1-2 liters/dayand adult live weights 194.4kg	Relatively better adaptive withtrypan tolerance polled or has floating type of horn and brown or black and white colour and glossy-red	Dilution with other zebu cattle and change in production system	Comparing with other breeds in the country better attention has been given to breeding and conservation both insitu and exsitu
FogeraCattle	Fogera plains around Lake Tana, Southern Gonder and adjoining areas of Gojam, zenga type breed	work, meat and milk purposes	Adaptive to seasonal flooding and the swampy conditions of the area. Tolerate tick and flies bitts relatively better than other breed in surrounding Black-and-white or black and grey coat color.Well-developed dewlap and naval flap and is docile.	Dilution risk with other small breed like smada small sized cattle, grazing lands have taken over by emerged cereal crops which i rice.	In-situ conservation and selection with ranch and ex-situ conservation with cryoconservation



3.1.2. Exotic dairy breed

The exotic cattle breeds belong to the group Taurus. They have got certain distinctive characteristics in comparison with indigenous cattle. They are high milk producers, they are hapless cattle. Though high producers they can't stand high temperature. Many exotic cattle breeds were brought to Ethiopia for cross breeding and upgrading purpose to improve milk production potentiality in our cattle. The important exotic cattle breeds were Holstein-Frisian, Jersey, Brown-Swiss, Guernsey, Red Dane etc.

Holstein – Friesian

Table 3.2 characteristics of Holstein – Friesian

World's heaviest cattle breed highest milk producer	
Origin	Holland
Horns	Medium sized
Ears	Small, erect
Head / Neck	Proportionate to body
Withers	
Angularity of body	Conspicuous
Barrel	Lengthy, Voluminous
Udder	Capacious with medium sized teats
Color	Black over white patches
Switch of tail	White
Age at maturity	1 year
Age at first calving	24 to 45 months
Milk yield	6000 kg / lactation (Used for cheese making)
Calving interval	13 months
Fat %	3 to 3.5

Jersey

Table 3.3 characteristics of Jersey

Smallest of European breeds	
Origin Jersey Island in English Channel	
Resistance to	: high temperature and humidity
Face	: Double dished
Head	: Small
Ears	: Erect
Color	: Fawn
Withers	: Sharp
Angularity of body	: Present
Udder	: Large, Capacious
Teats	: Well placed and medium sized
Tail	: Long
Switch of tail	: Black



Legs	:	Strong, straight, sufficient width
Milk yield	:	4000 to 5000 kg / lactation
Fat %	:	4 to 4.5
Age at first calving	:	25 to 26 months
Calving interval	:	1 year
Body weight	:	550 kg (male)
	:	400 to 450 kg (female)

Brown Swiss:

Table 3.4 characteristics of Brown Swiss

Second heaviest breed after Holstein Friesian		
Dual purpose breed		
Docile animal and also fleshy		
Body	:	Large sized
Head	:	Short
Neck	:	Lean
Head and Neck	:	Proportionate to body
Back, loin, croup	:	Leveled
Color	:	Different shades of brown, grey
Withers	:	Rounded
Udder	:	Large, Capacious
Milk yield	:	5000 kg / lactation with 4% butter fat
Age at first calving	:	27 months
Calving interval	:	1 year
Fat%	:	5
Body weight	:	600 to 700 kg (male)
	:	500 to 600 kg (female)

Ayrshire

Table 3.5 characteristics of Ayrshire

Beautiful cattle breed		
Origin	:	Scotland
Large animal and active		
Color	:	Reddish spots over white color
Withers	:	sharp
Rump, croup	:	Wide
Tail	:	Up to hock
Switch of tail	:	White
Angularity of body	:	Present
Horns	:	Medium sized, curving upward
Udder	:	Large capacious
Milk yield	:	4600 kg/ lactation
Fat %	:	3.5 to 4



Age at first calving	:	26 to 27 months
Calving interval	:	13 months
Body weight	:	450-500kg (male) 400-450kg (female)

Gurunsey

Table 3.6 characteristics of Gurunsey

Origin	:	Gurunsey island
Color of milk	:	Golden yellow because of presence of carotene
Color	:	Brown with white patches
Switch of tail	:	White
Angularity	:	Present
Milk yield	:	4000 to 5000 kg / lactation
Age at first calving	:	26 to 27 months

3.2. Recognizing reproductive organ and mammary gland of dairy cattle

3.2.1. Reproductive organ of dairy cattle

Understanding the anatomy and physiology of the cow's reproductive system is fundamental to good cattle management. Basic knowledge in this area will help producers do a better job of getting cows rebred, especially when using artificial insemination and estrus synchronization. It will also enable producers to better understand and control reproductive diseases and calving problems.

i. Anatomy

The ovary is the primary female reproductive organ and has two important functions: producing the female reproductive cell (the egg or ovum) and producing the hormones estrogen and progesterone. The cow's two ovaries are oval to bean-shaped organs that are 1—1.5 inches long and located in the abdominal cavity.

The secondary sex organs are a series of tubes that receive semen, transport sperm to the egg so it can be fertilized, nourish the fertilized egg (embryo), and allow the calf to be birthed. These organs include the vagina, cervix, uterus, uterine horns, and oviducts (also called Fallopian tubes), which each have a funnel-shaped opening called the infundibulum. Figure 1 presents a diagram of the complete reproductive tract anatomy.

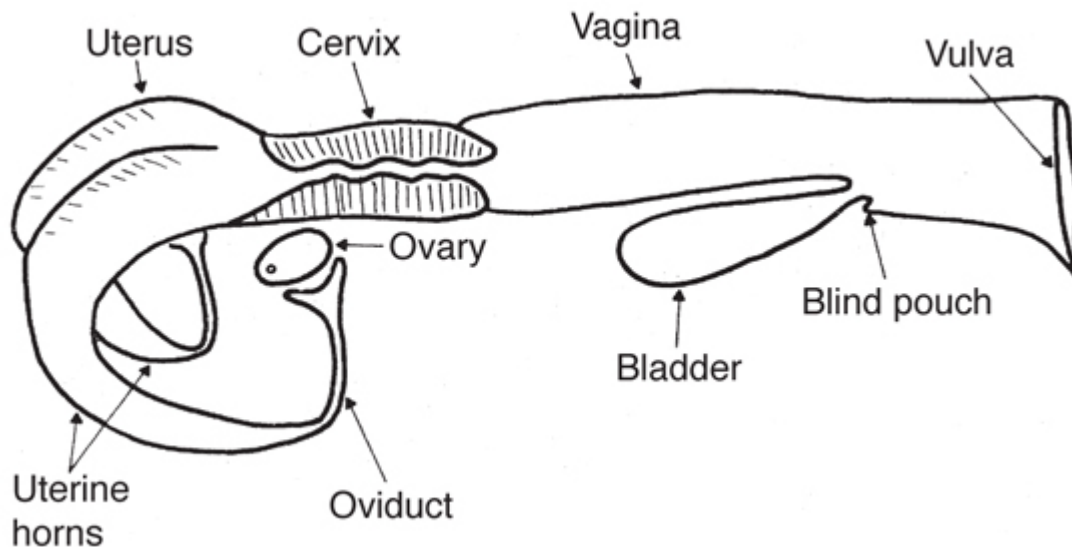


Diagram 3.1 Reproductive tract of the cow

ii. Hormonal regulation of the female reproductive tract

Normal reproduction in the female depends on hormones, which specific chemical substances produced by specialized glands are called endocrine glands. These secretions pass into the blood and lymph fluids and are transported to various parts of the body, where they exert several specific effects. Reproductive hormones may originate in the hypothalamus, pituitary, gonads, uterus, or placenta.

Hypothalamic hormones are produced in the hypothalamus, a portion of the brain that is the neural control center for reproductive hormones. The role of hypothalamic hormones is to regulate the release of other hormones from the pituitary gland, and many hypothalamic hormones are therefore called releasing hormones. The primary releasing hormone of reproduction is gonadotropin-releasing hormone (GnRH). GnRH controls the release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) from the pituitary gland, located at the base of the brain. These pituitary hormones regulate the production of estrogen and progesterone from the ovary. FSH stimulates the follicle's growth, development, and function, while LH causes the follicle to rupture and the corpus luteum to develop.

The female hormone estrogen is produced by the Graafian follicle on the ovary. Another hormone originating from the ovary is progesterone, which is produced by the corpus luteum. Each has an important role in the female reproductive process.

Estrogen regulates several functions: the development and functioning of the secondary sex organs; the onset of heat, or estrus (the period of sexual receptivity); the rate and type of body tissue growth,

especially fat deposition; and priming or preparing of the pre-pubertal heifer and postpartum cow for the onset of sexual activity.

Progesterone is the hormone of pregnancy. It suppresses the further development of follicles and estrogen secretion. While progesterone is being produced, the female does not exhibit estrus. Progesterone is necessary for preparing the uterus to receive the fertilized egg and maintains the proper uterine environment for pregnancy. Estrogen and progesterone are not completely separate in their effects because both are necessary for complete development of some important organs. Uterine development is initiated by estrogen and completed by progesterone. The fertilized egg will not attach and survive in the uterus unless that tissue has been properly prepared by the action of estrogen and progesterone. Estrogen causes rhythmic contractions of the uterus. On the other hand, progesterone has a quieting effect on the uterus, so there are no contractions that might disturb pregnancy.

Complete development of the mammary gland also depends on both hormones. Estrogen promotes the growth of the duct system, and progesterone is necessary for the development of the clusters of milk-secreting alveoli on the ducts. In general, estrogen makes things happen and progesterone calms them down.

A number of other hormones and hormone-like chemicals are known to have important roles in regulating the cow's reproductive system. Prostaglandins are secreted by many body tissues and perform a variety of functions. The prostaglandin primarily affecting the cow's estrous cycle is prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$), which is produced by the uterus. $PGF_{2\alpha}$ is the natural luteolytic agent that causes the corpus luteum to regress late in the estrous cycle and allows a new estrous cycle to be initiated in the non-pregnant female. In a pregnant cow, a signal is sent from the developing embryo to the uterus to prevent $PGF_{2\alpha}$ release, which allows the corpus luteum to persist throughout pregnancy. Maternal recognition of pregnancy is believed to occur between days 16 and 17 after fertilization. Injecting cows or heifers with $PGF_{2\alpha}$ between days 6 and 16 of the estrous cycle will cause premature regression of the corpus luteum, with the best results achieved among females injected on days 10 to 16.

Injecting $PGF_{2\alpha}$ during the first five (1—5) and last five (17—21) days of the estrous cycle will generally not cause luteal regression. The luteolytic response allows the use of $PGF_{2\alpha}$ in estrus synchronization programs in cow herds and initiates abortion in feedlot heifers. Estrogens, progestins, prostaglandins, and GnRH have all been used in various combinations in effective estrus synchronization programs.



3.2.2. Mammary gland of dairy cattle

The mammary gland of the dairy cow consists of four separate glands each with a teat. Milk which is synthesized in one gland cannot pass over to any of the other glands. The right and left side of the udder are also separated by a median ligament, while the front and the hind quarters are more diffusely separated.

The udder is a very big organ weighing, a round 50 kg (including milk and blood). However, weights up to 100 kg have been reported. Therefore, the udder has to be very well attached to the skeleton and muscles. The median ligaments are composed of elastic fibrous tissue, while the lateral ligaments are composed of connective tissue with less elasticity. If the ligaments weaken the udder will become unsuitable for machine milking since the teats then will often point outward, demonstrated in the picture below.

The mammary gland consists of secreting tissue and connective tissue. The amount of secreting tissue or the number of secreting cells is the limiting factor for the milk producing capacity of the udder. It is a common belief that a big udder is related to a high milk production capacity. This is, however, not true in general, since a big udder might include a lot of connective and adipose tissue. The milk is synthesized in the secretory cells, which are arranged as a single layer on a basal membrane in a spherical structure called alveoli. The diameter of each alveoli is about 50-250 mm. Several alveoli together form a lobule. The structure of this area is very similar to the structure of the lung. The milk which is continuously synthesized in the alveolar area is stored in the alveoli, milk ducts, and udder and teat cistern between milking.

60-80% of the milk is stored in the alveoli and small milk ducts, while the cistern only contains 20-40%. However, there are relatively big differences between dairy cows when it comes to the cistern capacity. This is of importance for the milking routines to be applied (see later demonstrated in the picture below).

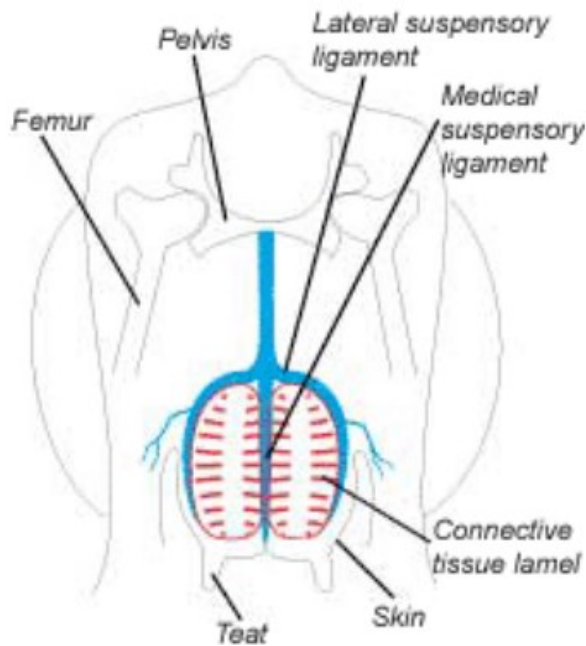


Figure 3.2 the suspensory structure of the udder

Milk Ejection

Removal of milk from the mammary gland is dependent on a functional milk ejection reflex. This is a neuro-hormonal dependent process. The ejection of milk results from a nervous stimulus that an animal associates with milking or suckling activity, such as manual massage of the udder teats, suckling, or sight and smell of the calf. The milking machine itself can also stimulate the reflex. The neural stimulus reaches the central nervous system and causes the posterior lobe to release oxytocin. Oxytocin reaches the mammary gland and myoepithelial cells, and contraction of these cells forces milk from the alveoli into the duct system. Milk then flows freely into the larger ducts and cisterns. Adrenalin inhibits milk ejection primarily by reducing blood flow to the gland so that sufficient concentrations of oxytocin cannot reach the receptors on the myoepithelial cells.

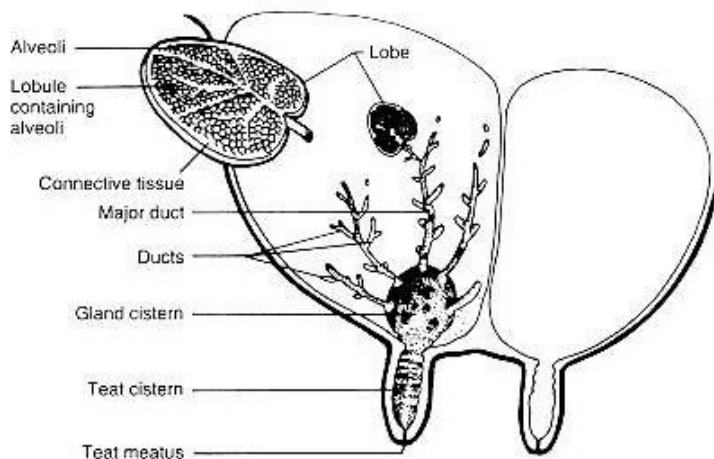


Diagram 3.3 the duct system in one quarter of the mammary gland of the cow



3.3. Carrying out estrus synchronization and heat detection procedures

3.3.1. Estrus cycle

The cow's reproductive cycle consists of a series of events that occur in a definite order over a period of days. The estrous cycle in the cow averages 21 days (range is 17—24). During this time, the reproductive tract is prepared for estrus or heat (the period of sexual receptivity) and ovulation (egg release). Diagram below outline the sequence of anatomical and hormonal changes that occur during a typical 21-day cycle in which pregnancy does not occur.

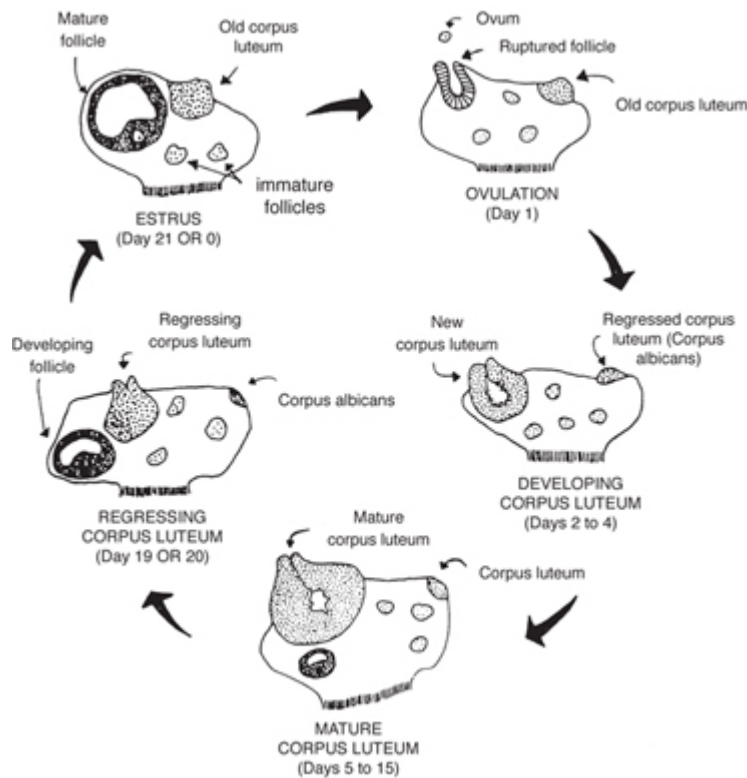


Diagram 3.4 21-day oestrous cycle in which pregnancy does not occur

Day 0: The cow is in estrus (standing heat) due to an increased concentration of estrogen. As estrogen levels reach a certain threshold level, a surge of LH is released by the pituitary. Near the end of standing heat, the mature Graafian follicle ovulates (ruptures) in response to this LH surge.

Days 1—2: The cells that formerly lined the follicle change and become the luteal cells of the corpus luteum. This change in cell form is caused by hormonal action, primarily the action of LH.

Days 2—5: The corpus luteum grows rapidly in both size and function. At this stage, numerous follicles may be seen on the ovary, but by day 5 they have begun to regress.

Days 5—16: The corpus luteum continues to develop and typically reaches its maximum growth and function by day 15 or 16. It secretes the hormone progesterone, which inhibits (blocks) LH release by the pituitary gland. During this period, the ovaries are relatively inactive except for the functional corpus luteum. No follicles reach maturity and/or ovulate because of high concentrations of progesterone.



Days 16—18: Increased follicular growth and accompanying estrogen secretion by the ovary stimulate PGF_{2α} secretion by the uterus, causing rapid regression of the corpus luteum.

Days 18—19: The corpus luteum is almost nonfunctional and progesterone release is suppressed, removing the blocking action of progesterone on LH and FSH. Of the several follicles that are initially recruited, one becomes dominant by a surge in rapid growth and activity. As this Graafian follicle grows, it secretes increasing amounts of estrogen, and the smaller follicles regress.

Days 19—20: With the increase in estrogen release by the Graafian follicle and a corresponding decrease in progesterone by the regressing corpus luteum, estrus or heat will occur (cycle has now returned to day 0). The high estrogen concentration in the blood triggers a release of LH near the onset of heat. Following this surge in LH blood concentrations, the mature follicle ruptures to release the egg, and the cellular tissue left behind becomes luteinized and forms a new corpus luteum (cycle has now returned to days 1—2). Progesterone again becomes the dominant hormone.

The timing given for these events is only approximating (based on a 21-day average) and differs for different cycle lengths (range of 17—24 days).

This discussion of events that occur during the estrous cycle is based on a full cycle in which pregnancy does not occur. If the egg is fertilized and begins developing in the uterus, the corpus luteum does not regress but continues to function and secrete progesterone. During pregnancy, no follicles develop to maturity and heat does not normally occur. Increased concentrations of progesterone promote uterine quiescence, providing the most favorable conditions for the developing fetus.

3.3.2. Estrus synchronization

Synchronization of estrus is the act of making a number of cows come in to heat at the same time. This allows better planning of breeding activities and wider use of A.I. This technology has been used in smallholder systems in many countries with variable results. In order to ensure success it is important that animals selected for treatment are healthy, in good condition and cycling and are not stressed or handled roughly during treatment and A.I.

Example: a farmer can use synchronization technology if the cow and heifer are not show heat during normal cycle and/or the animal have long CL the farmer can use this opportunity as a business man.

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Estrus synchronization is a good management tool that can help dairy producers to improve reproductive efficiency and economic returns.

- Shorten the breeding and calving seasons
- Leading to programmed feeding
- Easier management of the cows being at the same stage of gestation.
- Easy and convenient calving due to expected date of calving spread over a shortest possible period.
- Produce large number and uniform animals of desired germplasm
- Calving with feed availability and market demand for dairy
- Control heat period and allow more accurate AI service
- Improve the effectiveness and efficiency of AI service.

Types of synchronization protocols

Successful synchronization of estrus requires control of both the luteal and follicular phases of the estrous cycle. Estrous synchronization protocols can be grouped into four main classes:

- Prostaglandin F2 α (PG) based,
- Gonadotropin releasing hormone (GNRH) based,
- Progestin based,
- Combination

A. Prostaglandin F2 α (PG)-based protocols

Following ovulation, the different cells that make up the ovulatory follicle from which the egg emerged change function and become luteal cells that form the corpus luteum (CL). The primary purpose of the CL is to produce progesterone, a hormone that regulates several physiological functions: preparing the uterus for pregnancy, maintaining the pregnancy if fertilization occurs, and inhibiting signs of standing estrus and ovulation.

Prostaglandin F2 α (PG) is a naturally occurring hormone that signals the CL to degenerate (regress) if a pregnancy do not occur, allowing the cow to return to standing estrus. Giving an injection of PG will cause the regression of a CL before it would normally regress on its own; thus,

PG allows for control of the luteal phase of the estrous cycle.

During the first 5 days of luteal development and during natural CL regression (after day 17 of the estrous cycle), the CL is not responsive o PG. Therefore, PG will only work to regress the CL from days 5 to 17 of the estrous cycle. When an injection of PG is given during the responsive period (days 5 to 17), the CL will regress and cause the animal to exhibit standing estrus 48 to 120 hours after the injection.



If an animal does not have a CL present (a cow in the postpartum anestrus period or a heifer that have not reached puberty), she will not respond to an injection of PG. An animal must be cycling and be between days 5-17 of the estrous cycle to respond to an injection of PG.

B. Gonadotropin releasing hormone (GnRH)- based protocols

Gonadotropin releasing hormone (GnRH) controls the follicular phase of the estrous cycle.

Follicles grow in wave-like patterns, with each estrous cycle consisting of two or three follicular waves. The dominant follicle of each of these waves is capable of ovulating (releasing an egg) and having good fertility. However, when progesterone is present it inhibits a dominant follicle from ovulating.

Gonadotropin releasing hormone is a naturally occurring hormone that induces a luteinizing hormone (LH) surge, which causes ovulation of the dominant follicle even in the presence of progesterone. During an estrous cycle with three follicular waves, there are three time periods when a dominant follicle is present and can be induced to ovulate with an injection of GnRH. When a follicular wave is developing and a dominant follicle is not present an injection of GnRH will have no effect.

Following the induced ovulation of a dominant follicle by an injection of GnRH, a CL will form and a new follicular wave will be initiated.

C. Progestin-based protocols

During the estrous cycle when a CL is present and progesterone concentrations are high, standing estrus and ovulation are inhibited, but when the CL shrinks in size and the progesterone concentrations decrease, the animal then returns to standing estrus. Progestins, however, mimic the progesterone produced by the CL and inhibit ovulation, controlling the estrous cycle by extending the luteal phase of the cycle. Instead of the animal exhibiting standing estrus and ovulating after natural regression of the CL, the introduced progestin will cause the follicle to continue growing. Ovulation will be inhibited.

Following the removal of the progestin, progesterone concentrations will be low and standing estrus and ovulation will occur. However, when a CL regresses and cows are exposed to a progestin to inhibit ovulation of the dominant follicle, the follicle will continue to grow and will become a persistent follicle. Breeding animals at the first estrus after exposure for more than 7 days to a progestin will have decreased fertility, but subsequent ovulations will have normal fertility.

3.3.3. Heat detection procedures

Heat or estrus is the period when the female will accept the male and mate.

Estrus has been defined as a period when the female shows characteristic sexual behavior. 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

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farmers are behavioral signs and physical changes.

Table 3.7: heat detection in cattle

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

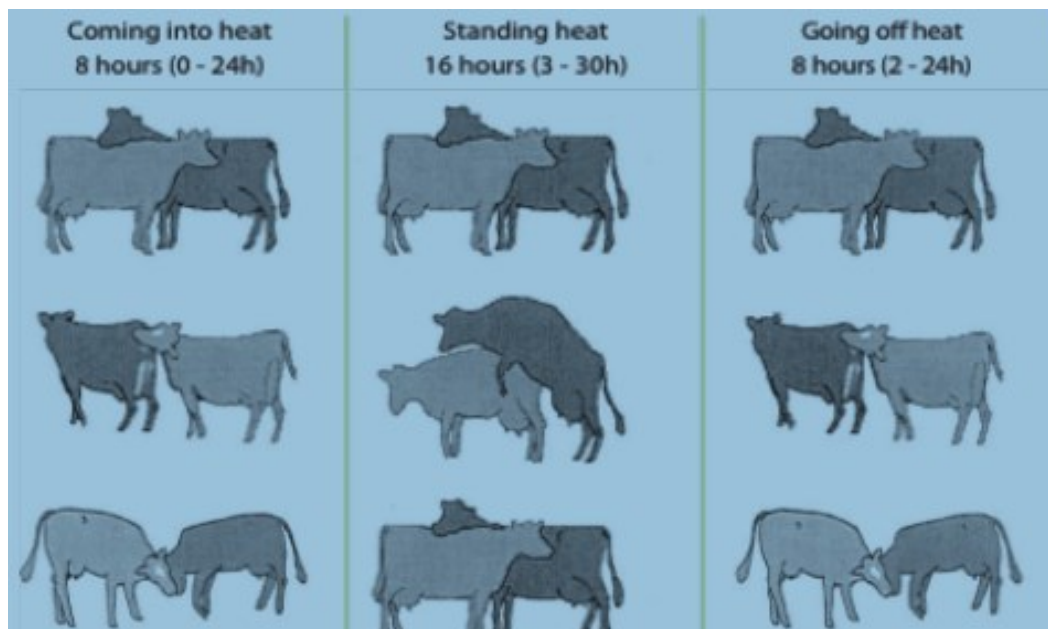


Figure 3.1 heat sign

a. Heifer first heat

Animals come into heat when they reach puberty. This occurs at different ages in the different ruminants:

- Well-fed heifers come into first heat at 10 - 20 months of age.

The duration of heat is very short.

- In cows it lasts for less than a day.
- In goats heat lasts for 1 - 3 days.
- In sheep heat lasts for 1 - 2 days.
- In pig heat lasts for 1-3 days.

A healthy animal which was not mounted by a male or given artificial insemination will come back into heat. Cattle will come into heat after 3 weeks (give or take a day or two), and female goats and sheep will come back into heat after 17 days (give or take a day or two).

b. Silent heat

There is ovulation, but the cow does not show heat signs (silent heat). This can occur in the first cycle after calving. Silent heat is the heat that will not be detected. When you see a cow for the first time in heat but is already 60 days after calving, you know that you have missed the first heat. Similarly when you see a cow in heat 6 weeks after the first heat, then you likely have missed the second heat.

It is a signal of bad heat detection when this happens regularly at your farm. Of course when a cow is pregnant she will not show heat either. Keep this option always in mind and when doubting, check your records or call a veterinarian.

When you inseminate your cow and you don't see her in heat the month after, it could be because the cow is pregnant or because the cow didn't show heat. This is why it is very important to watch the inseminated cow carefully every 3 weeks after insemination. So after 3 weeks, 6 weeks, 9 weeks, etc.

It is possible that the cow does not show heat due to other systemic diseases, poor body condition and breed types (Boran breed).

3.3.4. Aids to estrus detection:

- **Vasectomies' 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 (e.g. Calcium and Phosphorous mainly during the dry season) may exhibit silent heat (no behavioral signs), which can be detected by Vasectomies bulls.

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

- **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.
- **Detection of ovarian changes:** Use commercial kits to detect fall in progesterone



3.4. Securing and providing mating areas

The date of joining the sire to the breeding herd is determined by the cycle of estrus in female and sometimes by breeding season planned in the year.

Before selecting certain area for mating services, certain facilities should be available such as milk collection and processing, disease control and high standard of herd management. Resource should not stretch too far because continuity of operation is primarily considered. Area with primitive farm management a change in attitudes management practice is required before AI is introduced successfully. Field service can be organized in several ways.

Mating place/ area/ should:

- Free from any injury and injury cause materials
- Free from any disturbances
- Safe and clean
- Roads and accessibilities such as telephone
- Feed availability
- Free from any contaminated area

3.5. Using mating procedures and handling

3.5.1. Natural mating

Natural mating is using bulls to service the heifers. The choice of bull depends on many factors, such as:

- The heifer's age
- The heifer's size or live weight
- The heifer's stage of development
- Farmer's requirement for extra heifer replacements to increase herd size or achieve
- Desired culling rates
- Availability and cost of bulls.

D. 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.

E. 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

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- There is no opportunity to select the type of bull the farmer wants.

Natural mating can be done in two ways:

- I. **Free/pasture mating:** - This method of mating is practiced by farmers who own bulls which run full time with the cows. One bull can serve 20-25 cows. It has the Advantage no heat detection required and disadvantage of lack of accurate records and possibility of transmission of reproductive diseases e.g. brucellosis.
- II. **Hand mating:** - The bull is enclosed in its 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. Using beef sires over replacement heifers is a common practice on many dairy farms. The argument in favor of using beef bulls has been that small poorly developed dairy heifers are not big enough at 15 months to be serviced by dairy bulls (except in the case of Friesian heifers, other than by Jersey bulls). Problems can occur with physical damage when small heifers are mated with large bulls, because calving difficulties frequently occur with large calves being born to small heifers. However, heifers that have achieved minimum target live weight are generally capable of being successfully mated and calved to the larger dairy breeds. With the recent influx of large-framed.

Overseas genetics into what were previously considered small and safe, easy calving beef breeds, such as Angus, many producers now experience calving difficulties through mating their smaller heifers with these beef bulls. If newborn ‘bobby calf’ prices are low, the value of a beef cross calf is minimal compared with the potential cost of a dystocia and the resultant loss of milk production.

3.5.2. Artificial insemination techniques

Step 1: Restrain the animal to be inseminated

There are several things that should be kept in mind when choosing a location for inseminating cattle. Some of these include safety of both the animal and the inseminator, ease of use, and shelter from adverse weather. A gentle pat on the animal’s rump or a soft spoken word as the inseminator approaches will help to avoid startling or surprising the cow.

Step 2: Raise the tail with the right hand and gently massage the rectum with the lubricated glove on the left hand.

Place the tail on the back side of the left forearm so it will not interfere with the insemination process. Cup the fingers together in a pointed fashion and insert the left hand in the rectum, up to the wrist.

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Step 3: Gently wipe the vulva with a paper towel to remove excess manure and debris.

Be careful not to apply excessive pressure which may smear or push manure into the vulva and vagina. With the left hand, make a fist and press down directly on top of the vulva. This will spread the vulva lips allowing clear access to insert the gun tip several inches into the vagina before contacting the vaginal walls.

Step 4: Insert the gun at a 30° upward angle to avoid entering the urethral opening and bladder located on the floor of the vagina.

With the gun about 6 to 8 inches inside the vagina, raise the rear of the gun to a somewhat level position and slide it forward. To become a successful inseminator, it is very important to always know where the tip of the insemination gun is located.

The walls of the vagina consist of thin layered muscle and loose connective tissue. The insemination gun can be easily felt with the left hand in the rectum. As the breeding gun is inserted into the vagina, keep the gloved hand even with the gun tip. Manure in the rectum can often interfere with the inseminator's ability to palpate the cervix and gun tip. However, it is seldom necessary to remove all the manure from the bowel. Instead, keep the open hand flat against the floor of the rectum, allowing the manure to pass over the top of the hand and arm.

- Because the reproductive tract is freely movable, cows that have strong rectal and abdominal contractions in response to being palpated may actually push their reproductive tract back into the pelvic cavity.
- This will cause many folds to form in the vagina.
- In such cases, the insemination gun can get caught in these folds and little or no progress will be made until they are removed.
- If the cervix can be located, grasp it and gently push it forward.
- This will straighten the vagina and the gun should pass freely up to the cervix.
- The inseminator will note a distinct gristly sensation on the gun when it contacts the cervix.

The cervix consists of dense connective tissue and muscle and is the primary landmark for inseminating cattle. The cervix usually has three or four annular rings or folds. The opening into the cervix protrudes back into the vagina. Try to access when the pipette passes the last cervix ring.

Step 5: Once the gun is in contact with the external surface of the cervix, the inseminator is ready to begin threading the cervix over the end of the gun.

- Place the cervix on or over the insemination gun; the gun is not passed through the cervix.
- Excessive movement or probing with the insemination gun during this step is seldom productive.

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- The key to mastering this step of the insemination process is knowing how to hold and manipulate the cervix and concentrating on doing the work with the hand inside the cow, not the one holding the gun. When the gun first contacts the cervix, the inseminator will usually find that the tip is in the fornix area directly over the top of the opening of the cervix.

Step 6: Maintain gentle but steady forward pressure on the gun and slide the thumb and forefingers just in front of the gun tip and re-grasp the cervix.

Because the cervix is composed of dense connective tissue and muscle, it is difficult to clearly distinguish the gun tip when it is located within this structure.

Step 7: It is now time to check the gun placement and deposit the semen.

- Rotate the gloved hand until it lies on top of the cervix.
- With the index finger of that hand, locate the far end of the cervix. Pull back on the gun until the tip of it is directly underneath the index finger near the internal opening of the cervix. Raise the finger and slowly deposit the semen. Push the plunger slowly so that drops of semen fall directly into the uterine body.

Step 8: With proper AI technique and gun placement, semen will be deposited in the uterine body.

- Uterine contractions will then transport spermatozoa forward to the horns and oviducts with a good distribution of both sides.
- When the insemination gun is more than 1 inch through the cervix, all the semen will be deposited in only one horn.
- Be sure to raise the index finger after checking gun placement. Not doing so may obstruct one horn, creating a situation of uneven semen distribution.
- When checking gun tip placement, be careful not to apply excessive pressure. The delicate uterine lining is easily damaged, potentially causing infections and reduced fertility.

Step 9: After properly depositing semen, slowly pull the gun from the reproductive tract. Remove the gloved hand from the rectum. Check the gun tip for signs of blood, infection or semen leakage inside the sheath.

Disposable materials

- Full arm glove
- AI sheath
- Semen straw
- Clean paper

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A factor affects success of artificial insemination in Animals

- Species
- Milk production
- Body condition
- Lactation status
- Heat sign
- Uterine tone effects
- Quality of bull semen
- Inseminator experiences

3.6. Identifying common reproduction index or fertility indicators

Fertility has been defined as the desire and ability to mate, the capacity to conceive and nourish the embryo and finally the power to expel a normal calf and fetal membrane. Healthy cattle give expression to normal fertility by producing one viable calf per year. Fertility in dairy cattle is affected by environmental, genetic, disease and management factors. These influence the reproductive process at ovulation, fertilization or implantation or during gestation and parturition.

The commonest estimate of fertility rate is the percentage of mated or inseminated cows that become pregnant (pregnancy rate) or finally calve (calving rate). However, fertility can also be expressed in other ways as follows: a general fertility rate, which is the ratio of calves born to females of breeding age, expressed as a percentage; and a specific fertility rate, which measures the number of births within a given group or the total fertility rates of females over their reproductive life. Net reproductive rate was given as the extent to which the female calves of one generation survive to reproduce themselves as they pass through calf-bearing age, expressed as the number of female calves that survive per 100 females of breeding age.

Fertility rates can also be estimated prior to calving as the percentage of non-return rate. This is the number of cows bred that do not come back in heat and are thus assumed to have conceived and get pregnant. Cows start to produce milk immediately after calving. When a cow does not get pregnant she will not produce milk. This means that fertility management should be in order.

Infertility indicates a degree of reduced fertility, which results in failure to produce or delay in producing the annual live calf. Infertility interferes with the move from one generation to the other. Infertility has effect on efficient production of milk since pregnancy and parturition are necessary for the initiation and maintenance of lactation in the species. It adversely affects the production and productivity of local and crossbred cows and heifers in Ethiopia. Therefore, it is essential to use technological options and approaches to improve supply of desirable animal genetic material that incorporates estrus synchronization and AI can be tremendous.

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Risk factors related to Infertility in dairy cows are: Inadequate nutrition, Poor Reproductive Management, Increased incidence of diseases and Poor cow welfare.

3.6.1. Economic importance of infertility:

- Prolonging the calving interval, which results in less milk produced per cow and fewer calves born per year (Reduced production and reproduction)
- Increasing culling due to infertility and therefore, increased replacement costs.
- Increased labor, semen costs and veterinary bills i.e. treatment and prevention costs
- Prolonged Period of uterine diseases
- Handling un productive cows with extra expense
- Loss of market opportunity
- Reduced salvage value
- Repeated breeding cost.
- Reduced herd longevity

3.6.2. Indicators

For heifers: Age at the first calving

- Ideally < 24 months and limit not more than 30 months
- Heat detection and insemination should start from 12 months
- Heifers should be at least 350 kg when inseminated

For cows: Day between calving and insemination

- 1st insemination should take place within: Ideally before 45 days after calving and limit not later than 60 days after calving
- Day between calving and pregnant: Successful insemination should take place: Ideally before day 85 after calving and limit not later than 140 days after calving.

3.6.3. Dairy farmer and AI technician role on fertility management

B. Farmers:

- Perform selection of good dairy animal for improvement
- Ensure good dairy farming practices.
- Observe heat in time and present cows/heifers seen in heat for insemination
- Keep healthy and productive animals
- Conserve feeds for period of shortage
- Feed the animals properly
- Present cows for PD

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- Give calving reports
- Rear calves properly
- Keep close contact with AI technician
- Keep forward aspiration with genetic improvement of his herd

C. Inseminators:

- Should be skillful and proper AI service delivery
- Semen should be of high quality
- Ensure good storage of semen
- Programmed daily activity
- Perform proper recording as per the standard format
- Obey the standard service delivery rules and hygienic/sanitary conditions
- Accept or reject cows presented for insemination and tell to the farmer what to do next time
- Perform PD and advise farmer what to do
- Collect calving report If everything above is fulfilled, every 12 months a cow will have one calf.
- Outcomes of having good breed improvement and fertility manage
- Efficiency of fertility for well managed dairy cow

3.6.4. Handling of fertility problems

Understanding of fertility problems requires skills, knowledge and thoroughness of diagnostic procedures. The knowledge of contributing causes help to interfere the cause on time and to bring optimal fertility.

Optimum fertility occurs when a cow:

- Recommences cycling soon after caving (within 42-45 days).
- Conceive within 85 days (max. 100).
- Produces a viable zygote, which implants in the uterus and
- Survives to full term to produce a healthy calf which survives to adult-hood to continue the reproductive cycle to continue a second generation.

The best measure of animal fertility is its ability to produce a second-generation progeny. This can be achieved by maintaining full stages of reproductive cycle to obtain one calf per year per cow.

However, fertility efficiency dependent on:

- Obtaining normal uterine involution.
- Early resumption of ovulation.
- High efficiency of estrus detection.
- High conception rates per service.

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Thus, when we have good fertility management

- 65 to 70 percent of the cows conceive on first service.
- Average of 1.3 to 1.7 services per conception.
- Less than 10 percent of the cow with reproductive “problems”
- Calving interval between 12 to 13 months.

3.6.5. Outcomes of good breeding and fertility management plan

I. Calving interval (CI)

It is the period between calving. The most productive interval is one year. In order to reach this optimal period the cow should become pregnant with in three months after calving. It is calculated as the interval between two successive calving. It is an indicator of a cow’s reproductive performance. The longer the calving interval is, the lower the average dairy milk production will be. The longer the dry period is, the longer you have to feed a cow that does not produce milk that bring the income loss which is not economical to the farmer. Therefore, to shortening the calving Interval means the cow should come in heat within 40 days after calving so that the farmer should:

Give good management care that means feeding, housing and health care to the cows and assure that the cow is in good condition.

- Close follow up and pay attention to heat detection.
- Consult AI technician in time.
- The animal should be inseminated and/or served within 60 to 80 days after calving.
- Keep clear records
- Regency test should be done after 2-3 month of insemination or service.

II. Lactation Length

It refers to the period of time between calving and drying off. Breed, level of nutrition, parity, suckling, and other management factors affect lactation length. Indigenous zebu breeds were found to have shorter lactation length compared to crossbred dairy cows. Dairy cows on good feeding regime will have longer days in milk compared to those kept under poor feeding regime. Therefore attempts to increase milk yield through cross breeding, selection, better feeding and improved management will also extend lactation length.



Table 3.8 Fertility management goal indicators

Indicator	Unite	Goal	Limit
For individual cow			
Age at first calving	Month	<24	>30
Calving interval	Month	<12	>14
Return to heat after calving	Day	<40	>60
No. of insemination per conception	Number	<1.7	>2.5
Days of dry period	Day	50-60	<45 or >70
Days b/n calving & conception	Day	<80	>140
For herd			
Average calving interval	Month	<12	>14
Heat after calving	Day	<40	>60
insemination after calving	Day	<45	>60
Cows return to heat after 60days after calving	%	90	<90
No. of insemination per conception	Number	<1.7	>2.5
Rate of heifers get pregnancy after 01 service	%	>65	<60
Rate of matured cows get pregnancy after 01 service		>50	<40
Rate of matured cows have to do 03 service	%	<10	>10
Days of dry period	%	50-60	<45 or >70
Interval b/n calving and next pregnancy	Day	85-110	>140
Rate of the cows with Interval b/n calving and next pregnancy >120	%	<10	>45



Self-check 3

Written test

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

1. The force available to breeders to change gene frequency in a population is:
 - A. Breeding
 - B. Selection
 - C. Mutation
 - D. None of these
2. A process by which certain individuals in a population are preferred over others for the producing next generation, is called
 - A. Inbreeding
 - B. Pedigree testing
 - C. Selection
 - D. Progeny testing
3. Mating of closely related individuals is called
 - A. Inbreeding
 - B. Crossbreeding
 - C. Line breeding
 - D. Outbreeding
4. The process that determines which individuals become the parents for the first time is known as
 - A. Culling
 - B. Replacement selection
 - C. Selection
 - D. All
5. The mating of sires of one breed or breed combination to dams of another breed or breed combination is known as
 - A. Line breeding
 - B. Cross breeding
 - C. Inbreeding
 - D. Heterosis
6. Progeny testing is the method of choice for selection of breeding
 - A. males
 - B. females
 - C. heifers
 - D. Calves
7. Mark the estrus Cycle of a healthy cow:
 - A. 21 days
 - B. 18 Hours
 - C. 281 days
 - D. 30 days
8. Mark the time of insemination of a cow in heat
 - A. At the onset of heat
 - B. Mid of estrus
 - C. Between mid to late of heat
 - D. Between late to end of heat
9. Mark the optimum calving interval for the high level of breeding efficiency in cow
 - A. 250 days
 - B. 310 days
 - C. 395 days
 - D. 450 days

10. Gestation period in case of cow is of

- A. 282 days
B. 151 days
C. 307 days
D. 335 days

11. Mark the optimum calving interval for the high level of breeding efficiency in cow

- A. 250 days
B. 310 days
C. 390 days
D. 420 days

12. Condition when young one is no longer fed milk

- A. Shearing
B. Weaning
C. Calving
D. Mating

13. The sate when animal first becomes sexually mature?

- A. Service period
B. Calving
C. Puberty
D. Mature

14. The process of removal of undesirable or non-productive animals from herd is called?

- A. Selection
B. Culling
C. Grading up
D. None of these

Test II: Short Answer Questions

1. List the most known Ethiopian dairy cattle breeds.
2. What is the difference between milking and dry cows?
3. Why is important managing cow during dry period?
4. How long is the optimum length of the dry period recommended before calving?
5. Why is important Steaming up for dry period cows?



Operation Sheet-3

3.1.

Performing of artificial insemination

D. Tools and equipment

- Insemination gun
- Liquid nitrogen
- Semen straw
- Straw cutter
- tissue paper
- Thermo flask

E. Procedures/Steps/Techniques of artificial insemination

1. Check identity of cow
2. Check thermos temperature
3. Select semen not close to cow
4. Place straw in thermos for 15 second
5. Clean straw by tissue paper
6. Cut the plug at the end of straw
7. Put the straw in the insemination gun sealed end first
8. Push the plunger of insemination gun until the semen is visible
9. Keep the insemination gun in your hand or between your teeth
10. Clean the vulva
11. Put your hand in the rectum and remove manure
12. Locate the cervix and uterus with your hand in the rectum
13. Grasp the cervix with your hand and straighten any vaginal folds that encounter with tip of gun
14. Open the cervix in the center if not opened
15. Pass the gun in the cervical folds
16. the gun Slip forwards easily and reach uterine body
17. make sure the semen is deposited in the uterine body



Lap test-3	Performance Test
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Name.....

ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 50 minutes. The project is expected from each student to do it.

Task-1 Perform artificial insemination



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