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Kenya Agricultural & Livestock Research Organization

MESPT
MICRO ENTERPRISES SUPPORT PROGRAMME TRUST

MINISTRY OF FOREIGN AFFAIRS OF DENMARK
Danida

Dairy Value Chain Manual

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Disclaimer

This training guide is for advisory use only. Users of this training guide should work closely livestock extension officers. It is also advised that this training guide should be used in conjunction with the respective value chain manual and other relevant resource materials.

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FOREWORD

The Micro Enterprises Support Programme Trust (MESPT) is a local development organization founded in 2002 through a partnership between the Government of Kenya (GoK), the European Union (EU), and later, the Royal Danish Government. MESPT's main goal is to eradicate poverty by supporting the growth of micro-enterprises, including agricultural production, agribusiness, and afro-processing. This support aims to foster social, economic, and environmentally sustainable growth by increasing access to financial and business development services, creating jobs, and promoting sustainable micro-enterprises. Our vision is to build a more prosperous society, and our mission is to provide sustainable business development and financial services to smallholder farmers and agri-MSMEs in Kenya.

For over two decades, our team of professionals has been at the forefront of developing cost-effective and scalable solutions that promote financial inclusion and support the growth of sustainable agribusinesses. We accomplish this by providing tailored financial solutions that meet the specific needs of various agricultural value chains, delivered through a wholesale lending model to financial service providers such as SACCOs, MFIs, and Farmer Cooperatives. These providers, in turn, extend loans to smallholder farmers and micro agricultural enterprises.

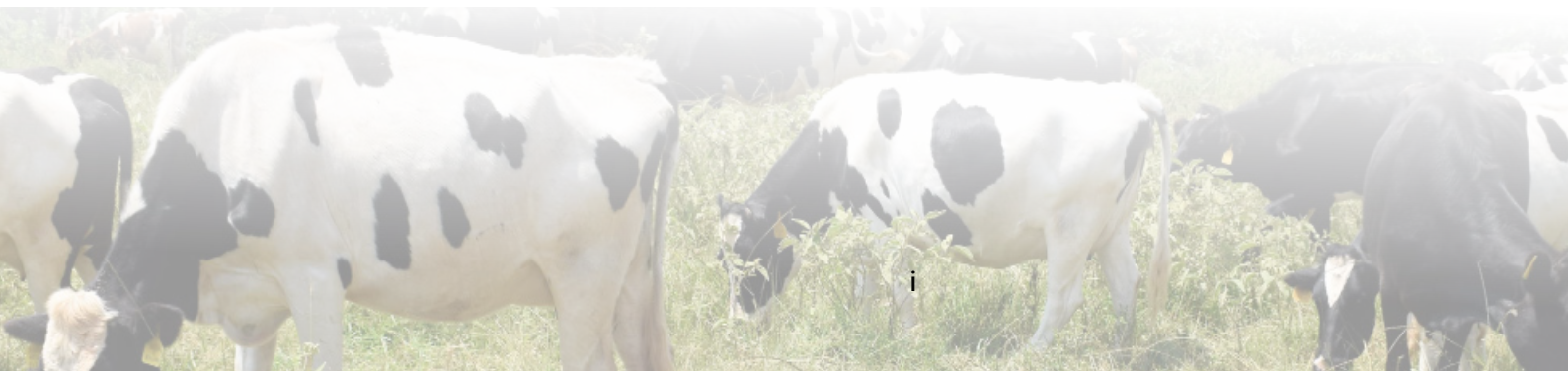
Our approach emphasizes delivering integrated financial and business development services to smallholder farmers and MSMEs in Kenya, helping them access finance, boost agricultural productivity, improve afro-processing and connect to markets. Over the years, we have worked closely with county governments, development agencies, donors, and investors to strengthen business development capacities in the agricultural sector, using a unique tripartite model that connects farmers, SMEs, and financial institutions.

Dairy is among key value chains that have been supported by MESPT over the years through various interventions in order to enhance commercialization. MESPT appreciates the importance of documenting best practices for the value chain in facilitating effective delivery of training for farmers and Agri-preneurs. Therefore, MESPT has facilitated the development of this manual alongside the value chain trainers' guide and other resource materials through Green Employment in Agriculture Programme (GEAP) with support from DANIDA.

This manual is expected to enhance effectiveness in delivery of trainings on Good Agricultural Practices and commercialization of the value chain. I am optimistic that this manual will be helpful to partners in the value chain including county governments. I am grateful to DANIDA for the continued support to MESPT programmes. I am also thankful to the value chain experts who spearheaded compilation of this manual.

Rebecca Amukhoye,

Chief Executive Officer, Micro-Enterprises Support Programme Trust



PREFACE

The Green Employment in Agriculture Programme is a 5 years' programme (2021 to 2025) funded by DANIDA and implemented by Micro-Enterprises Support Programme Trust (MESPT). GEAP seeks to contribute directly to Kenya's vision 2030 and to one of Denmark-Kenya Strategic Framework on accelerated decent employment creation in MSMEs and improved competitiveness of targeted value chains in agriculture which will contribute to transforming the economy towards a greener and more inclusive growth.

GEAP programme targets 40,000 smallholder farmers and will be implemented in 12 counties namely, Kilifi, Kwale, Nakuru, Nyandarua, Siaya, Kisii, Kakamega, Bungoma, Trans Nzoia, Uasin Gishu, Makueni and Machakos. The programme facilitates increased commercialization, decent employment, and green transformation through targeted interventions in seven selected agriculture value chains that include, Dairy, Export Vegetables, Mango, Avocado, Indigenous Poultry, Coconut, and Aquaculture.

MEST through GEAP tasked multidisciplinary teams to develop resource materials tailored for extension service providers and farmers. A dairy training guide is one of the series of the materials that were developed. MESPT further tasked dairy value chain experts to develop a Training manual for the dairy value chain. The manual is to be used as an instructional manual for training on implementation of good agricultural practices, value addition and marketing for the dairy value chain. Relevance of the content is based on needs identified among value chain players, actors and aligned to GEAP project objectives. The training content is drawn from relevant dairy resource materials.

This Training manual consists of two sections. Section I comprises information about the dairy value chain, guidelines and notes for facilitators while section II comprises of the training modules. The modules have a uniform outline that ensures every aspect of the handbook is fully covered using approaches that the trainees can easily understand. The modules are progressively arranged to achieve a logical flow of the sessions. Recommended training durations are also provided.

A variety of delivery methods are outlined and where possible, demonstrations and practical work is incorporated. To maintain quality of training across various groups and settings, trainers' guidelines, program, training methods and training evaluation have been provided in the manual. It is advised that the training manual should be used in conjunction with the respective value chain handbook and other relevant reference materials. It is also recommended that participant hand outs and facts sheets are provided to trainers.

MESPT is grateful to the value chain experts who spearheaded the development and production of this training manual. It is my hope that counties and other users will adopt and optimally use this resource for the dairy value chain development so as to increase productivity and profitability while ensuring a greener and more inclusive growth.

Doreen Kinoti

Programme Manager, Green Employment in Agriculture Programme

ACKNOWLEDGEMENTS

The Green Employment in Agriculture Programme (GEAP) participating counties (Kilifi, Kwale, Nakuru, Nyandarua, Siaya, Kisii, Kakamega, Bungoma, Trans Nzoia, Uasin Gishu, Makueni and Machakos) are acknowledged for providing resource persons in compilation of the document. The technical support and expertise provided by Kenya Agricultural and Livestock Research Organisation in development of the document is appreciated. Thanks to the Royal Danish Government's Danish International Development Agency (DANIDA) for facilitating the development of this re-source material. Micro Enterprises Support Programme Trust (MESPT) is appreciated for co-ordinating the process of development and production of this document.

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List of Abbreviations

ADG: Average Daily Gain (growth rate of an animal per day)

AI: Artificial Insemination

BW: Body Weight

CP: Crude Protein (a measure of protein content in animal feed)

DM: Dry Matter (the portion of feed excluding water content)

DMI: Dry Matter Intake (the amount of feed consumed, excluding water)

FCR: Feed Conversion Ratio (a measure of the efficiency of an animal in converting feed into body mass)

FMD: Foot and Mouth Disease

LWG: Live Weight Gain (growth in weight of an animal)

ME: Metabolizable Energy (energy available for growth, maintenance, and production after digestion)

TMR: Total Mixed Ration (a method of feeding livestock where all feed ingredients are mixed together)

ASTGS: AgricultureSector Transformation and Growth Strategy

Definition of Terms

Artificial Insemination (AI)-A breeding method where semen is collected from a bull and manually inserted into the reproductive tract of a cow.

Calf rearing refers to the practice of raising young calves (typically dairy or beef cattle) from birth until they are old enough to be weaned, integrated into the herd, and begin their production roles, such as milk production in dairy cows or growth for meat production in beef cattle.

Calving Interval-The time between successive calvings, ideally 12–13 months. A shorter interval ensures steady milk production.

Concentrates-Energy-dense feed supplements, such as grains, oilseeds, or processed feed, used to boost milk production and energy intake.

Culling-The process of removing cows from the herd due to low productivity, health issues, or old age.

Dry Period-The rest period between the end of lactation and the next calving, usually lasting 45–60 days. It allows the cow's body to recover and prepare for the next lactation.

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

Gross Margin-The difference between total revenue (from milk, calves, and manure) and variable costs (feed, labor, veterinary care).

Heat Detection-The process of identifying when a cow is in estrus (heat) and ready for breeding, usually indicated by behaviors like mounting or restlessness.

Lactation Period-The period during which a cow produces milk after calving, typically lasting about 305 days.

Mastitis-An infection or inflammation of the udder, often caused by bacteria. It negatively impacts milk production and quality.

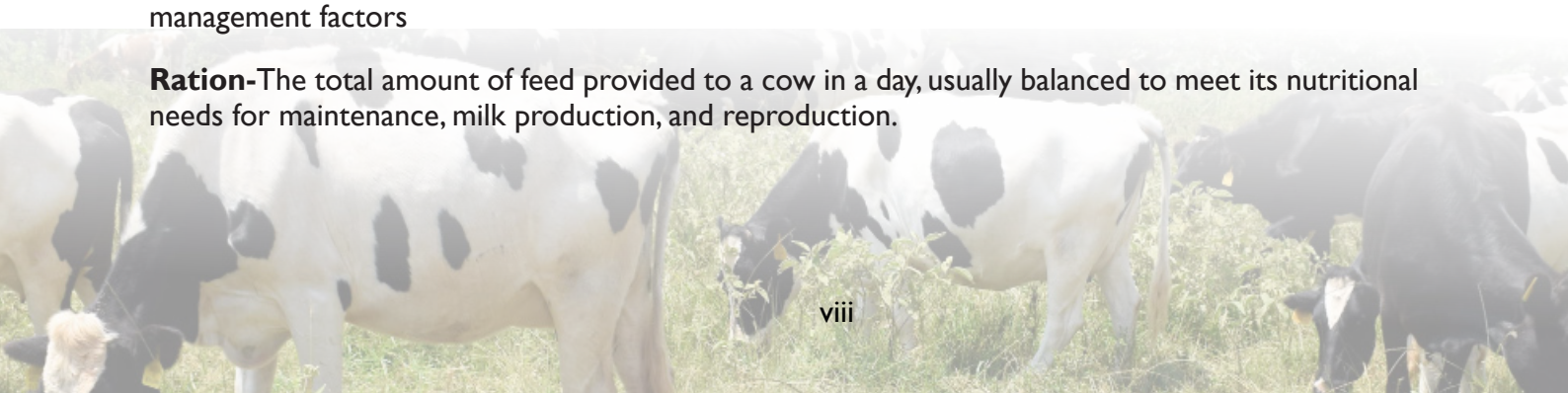
Milk Fever-A metabolic disorder caused by low calcium levels in the blood, often occurring around calving.

Milk Yield- The amount of milk produced by a cow over a specific period, usually measured daily, monthly, or annually.

Milking Parlor-A facility designed for milking cows efficiently and hygienically, often equipped with automated systems.

Production systems refer to the various methods and approaches used to manage and produce milk and other dairy products. These systems are tailored to specific environmental, economic, and management factors

Ration-The total amount of feed provided to a cow in a day, usually balanced to meet its nutritional needs for maintenance, milk production, and reproduction.

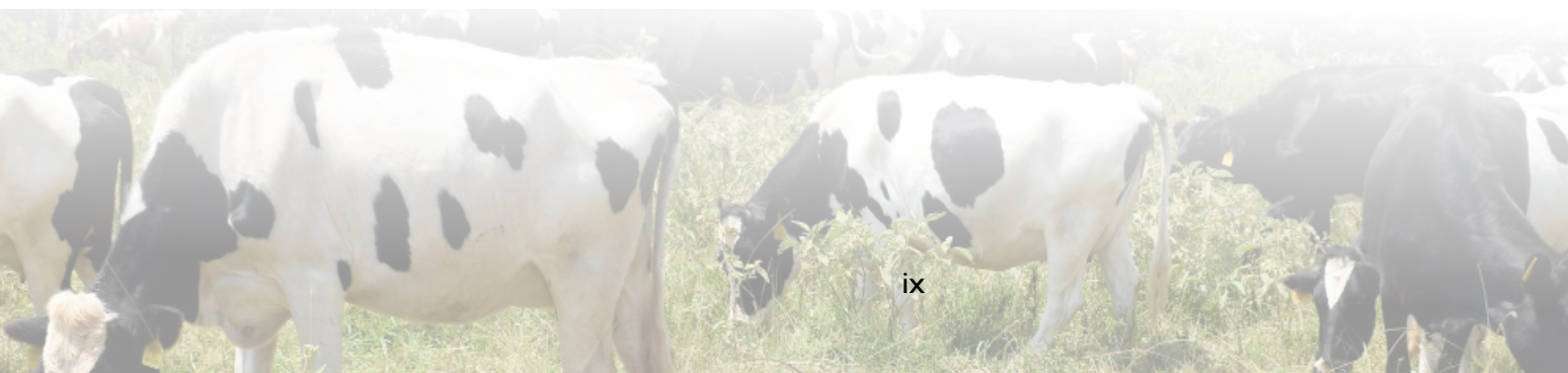


Silage-Fermented, high-moisture fodder made from crops like maize or grass, used as a feed supplement for dairy cows.

Udder-The mammary gland of the cow, which produces and stores milk.

Weaning-The process of transitioning a calf from milk to solid feed, typically done at 8–12 weeks of age.

Zero-grazing unit for dairy cows is a livestock management system where cows are kept in a confined area and do not graze on pastures. Instead, their feed is harvested and brought to them. This system is commonly used in areas where grazing land is limited or unavailable, or where controlled feeding is essential to optimize milk production.



CHAPTER 1. INTRODUCTION

1.0 Background Information

The dairy sector involves the production and processing of animal milk from different species of livestock (cattle, camels, goat and sheep). Compared with other dairy animals, dairy cattle present many advantages in terms of ease of milking, udder size and the animal's ability to store milk, and milk yield. Thedairy cattle industry supports over 150 million households globally (FAO, 2021).

There are over 264 million dairy cows producing over 600 billion litres of milkper year globally in different regions compared to proportion of milk produced (FAO, 2021). Africa as a continent with 18% of the world population, producesonly 6% of dairy cattle milk.

1.1 The dairy sub-sector in Kenya

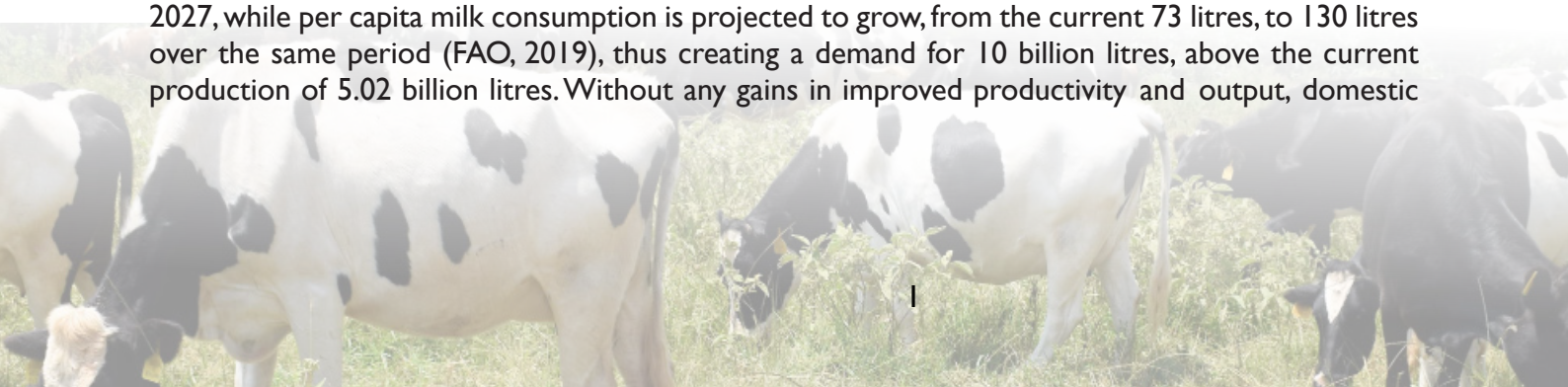
The dairy sub-sector in Kenya contributes 4.5% of the Gross Domestic Product (GDP), approximately 14% and 44% of the Agricultural and Livestock GDPrespectively (KNBS, 2022). The sub-sector is currently valued at KES 237 billion (SDL, 2022).

The dairy value chain is ranked highly under the Bottom-up Economic Transformation Agenda (BETA) Government model as one with the highestpotential impact in addressing high cost of living, generating revenue, increasing foreign exchange earnings, creating jobs and with inclusive growth. The BETA is aligned with Vision 2030, Medium Term Plan (MTP) IV and AgricultureSector Transformation and Growth Strategy (ASTGS) that focuses in transforming the livestock sub-sector (including dairy) to a modern commercially oriented sector through increased productivity and value addition.

The sub-sector supports 1.8 million dairy farmers, of which 80% are smallholder farmers, and over 750,000 actors along the value chain (Dairy Masterplan,2022). The cattle, camels, goats and sheep population has been estimated at 21,200,347, 4,427,881, 33,681,560 and 24,801605, respectively (SDL, 2021).The total annual milk production from the four species of livestock is estimatedto be 5.02 billion litres of which 3.715 billion litres (74%) is attributed to cattle, 1.054 billion litres (21%) to camels, 0.201 billion litres (4%) to goats and 0.05% to sheep (FAOSTAT, 2022).

The population of the exotic dairy cattle and their crosses has been estimatedat 5,017991, which represent 24% of the total cattle population (SDL 2021).The dairy cattle accounts for 85% of the 3.715 billion litres of milk producedby cattle while the indigenous cattle account for 15% (KDB, 2023).

The Kenyan human population has been estimated at 53.01 million (WorldOMeter,2021) with per capita consumption of 73 litres (KDB 2023). This implies Kenya has a milk deficit of 550 million litres. This deficit is expected to worsen as the human population is projected to reach 62.54 million by 2027, while per capita milk consumption is projected to grow, from the current 73 litres, to 130 litres over the same period (FAO, 2019), thus creating a demand for 10 billion litres, above the current production of 5.02 billion litres. Without any gains in improved productivity and output, domestic

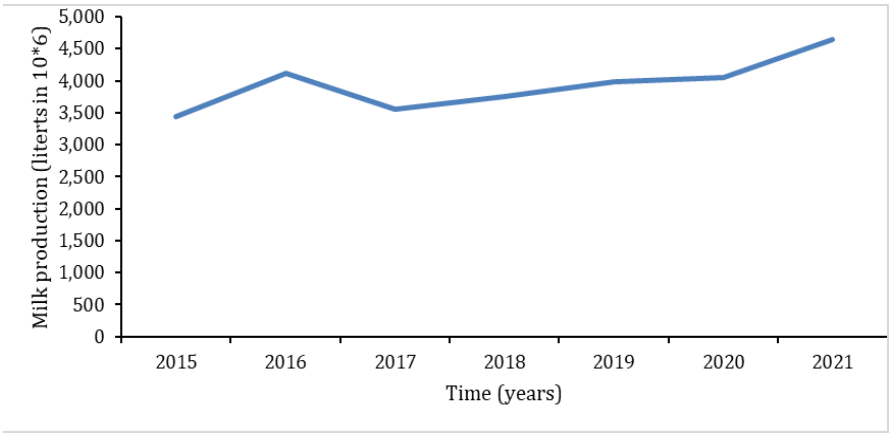


milk supply will fall short of demand by over 4.5 billion litres by 2027 (KDB, 2023) and this is expected to negatively affectthe dairy cattle value chain.

1.2 Milk production In Kenya

1.2.1 National Milk Production Trends

Figure 1: Presents the milk production trends in Kenya for the last seven years. The production trends demonstrate an increase in milk production. The production trends could be attributed to increasing number of dairy cattle, improved management and breeding. Increasing the number of dairy cattle for improved milk production may not be sustainable due to limited production resources such as land, feed and water.



National Milk Production Trend (SDL 2015-2021).

1.2.2 The importance of dairy farming in Kenya

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

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

- Poor management especially inadequate feeding
- Poor health management
- Poor breeding management that leads to long calving intervals.

CHAPTER 2. DAIRY PRODUCTION SYSTEMS

2.0 Introduction

The dairy animals are mainly raised under three main production systems,which include intensive, semi-intensive and extensive systems. The smallholder/ pastoral systems own 80% of the dairy animals and produce 70% of the milk. The smallholder systems are operated under subsistence units with herd size of 3-5 cows of exotic and their crossed, kept under either intensive, semi-intensive or extensive systems.

On the other hand the pastoral systems raise indigenous cattle and their crosses under open extensive grazing systems. The animals mainly depend on natural pastures, hence move from one place to another during drought period depending on availability of water and pasture. In this system the livestock provide up to 90% of the human livelihoods (Nyariki and Amwata, 2019). The large-scale farms own 20% of the dairy animals in Kenya and produce 30% ofthe milk. They are more capital intensive and commercial oriented.

In Kenya, dairy production is an important part of the Livestock sector, and it generally operates within three main production systems:

2.1.1 Intensive or Zero-Grazing System:

This system is typically practiced by smallholder farmers, especially in high-potential agricultural areas with limited land. In the zero-grazing system, cows are kept in stalls or small enclosures, and farmers provide them with feed, which includes fodder, silage, and concentrate supplements. This system helps maximize milk production on limited land and is often associated with more labor and higher management input, as cows rely on a controlled feeding regime.

Source: Department of livestock production, Nyandarua County

1. **Semi-Intensive System:**

In this system, dairy cattle graze on pastures part of the day and are supplemented with additional feed, either in the evening or during dry periods when pasture quality may be low. This system is suitable for farmers with more land available, particularly in medium-potential areas. It balances grazing with some controlled feeding, which can lower feed costs compared to intensive systems.

2. **Extensive or Free-Grazing System:**

Practiced mainly in low-potential areas with larger land availability, extensive grazing involves allowing cattle to graze freely on open pasture. This system is common in regions with larger-scale farming or areas with communal lands, where dairy production is combined with other livestock, like beef cattle. It is the least labor-intensive but may result in lower milk yields due to seasonal feed variability and lack of supplementation.

2.2 Advantages and challenges of each of the dairy production systems

2.2.1 Zero-Grazing (Intensive) System

Advantages:

High Productivity: This system allows for controlled feeding, enabling farmers to provide nutrient-rich diets that can lead to higher milk production per cow.

Disease Management: Confined animals are easier to monitor, allowing for prompt disease detection and treatment.

Land Efficiency: Ideal for areas with limited land as cows are kept in small enclosures.

Waste Management: Manure can be easily collected and used for biogas production or sold as fertilizer.

Challenges:

High Cost: Requires significant investment in infrastructure (barns, feed storage) and feed, which can be expensive.

Labor Intensive: Requires constant feeding, cleaning, and health monitoring, which increases labor costs.

Waste Disposal: Large amounts of waste need to be managed properly to avoid environmental pollution.

2.2.2 Semi-Zero Grazing (Semi-Intensive) System

Advantages:

Balanced Nutrition: Allows cows to graze and receive supplemental feed, balancing cost and nutrition for potentially better yields.

Reduced Feed Costs: Partial grazing helps cut down on the need for purchased feed.

Moderate Land Requirement: Works well for small- to medium-sized farms that have limited grazing land.

Challenges:

Variable Productivity: Milk production may fluctuate based on the quality and quantity of available grazing.

Infrastructure Requirements: Requires fencing, watering facilities, and shelter to accommodate both confinement and grazing.

Disease Risks: Exposure to grazing fields increases the risk of parasites and diseases compared to full confinement.

2.2.3. Open Grazing (Extensive) System

Advantages:

Low Cost: This system minimizes costs for feed and infrastructure, as animals rely mostly on natural forage.

Less Labor Intensive: Animals graze freely, requiring less day-to-day management.

Natural Environment: Cows roam freely, which is closer to their natural behavior and may result in less stress.

Challenges:

Low Milk Yield: Productivity is generally lower due to inconsistent nutrition from natural pasture, leading to lower milk yields.

Weather Dependency: Grazing is highly affected by seasonal changes, with shortages in dry seasons impacting animal health and productivity.

High Disease Exposure: Grazing areas can expose cows to parasites and infectious diseases, requiring regular health monitoring and vaccinations.

Each system presents different trade-offs in productivity, cost, and management, influencing the choice based on available resources and land.

2.3 Dairy Cattle Breeds

In Kenya, dairy farming relies on specific breeds known for their high milk production and adaptability to the local climate. The main dairy breeds in Kenya include:

The Friesian.

A Friesian cow

Purpose: Milk production

Potential yield: 40-60 litres milk/day

Average body size: Large (500-550kg)

Description: Black and white short haired coat, short horns

Advantages:

- High milk production potential with low butter fat content of about 3.2%
- **Note:** Milk production will depend on level of feeding and other management.
- **Disadvantages:**
- Heavy feeder (requirements high (90-110Kg fresh forage/day)
- Susceptible to diseases, susceptible to milk fever Susceptible to high temperatures
- Large amounts of water (min 60 lts/day, more for heavy yielders)

The Ayrshire

An Ayrshire cow

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

Potential yield: 30 litres/day

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

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

Advantages:

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

Disadvantages:

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

The Guernsey

A Guernsey cow

Purpose: Milk production. Heifers generally come into milk at about two years ofage.

Average body size: Medium (average live-weight 400kg). The cow weighs 450 to500 kg.

Description:

- The colour varies from yellow to reddish-brown with white patches.
- They have a finely tuned temperament, not nervous or irritable.
- Physically the breed has good dairy conformation and presents the visual impression of a plain

animal bred for utility rather than good looks.

- They have an attractive carriage with a graceful walk, a strong back, broad loin, wide rump and deep barrel, strong, attached udder extending well forward, with the quarters evenly balanced and symmetrical.
- The Guernsey bull has an attractive individuality, revealing ample vigour and masculinity. It has smooth-blending shoulders showing good refinement, strength and even contour.

Advantages:

- High milk production potential (25 lt/day).2. Milk has moderate butter fatcontent 4.3%
- Feed requirements: Moderate (65-85Kg fresh forage/day).
- Guernsey are efficient converters of feed to product, being of intermediate size, Guernsey produce their high quality milk while consuming 20 to 30 percent less feed per pound of milk produced than larger dairy breeds
- Guernsey reaches reproductive maturity at an early age and can calve at 22 months of age. This provides an early return on investment
- Guernsey are well known for having the minimum of calving complications
- Guernsey are adaptable to all climates and management systems and lack any known undesirable genetic recessives.

The Jersey

A Jersey Cow

Purpose: Milk production.

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

Average body size: Small - medium (350 Kg)

Description:

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

They have protruding eyes.

This breed is well known for milk with high quality - it is particularly richer in protein, minerals and trace elements than those from the larger dairy breeds. The milk is also rich in colour which is naturally produced from carotene.

Milk production potential is moderate (20 Lt/day), depending on feeding and management regime.

Advantages:

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

Source: KALRO

A Friesian-Sahiwal crossbreed dairy cow is a cross between a Friesian and a Sahiwal cow, and has characteristics of both breeds:

Milk production: Friesian-Sahiwal crossbreds are known for their high milk production, averaging 2,500 kg per lactation. This is higher than the Sahiwal breed, which averages 1,500 kg per lactation.

Disease resistance: The crossbreed is resistant to diseases and harsh climatic conditions, unlike the exotic Friesian breed.

Calving: The crossbreed has few calving problems and calves grow quickly, allowing heifers to be served at a younger age.

Ease of handling: The crossbreed is easy to handle and milk.

Hooves and legs: The crossbreed has strong hooves and legs and can find feed easily.

Body weight: The crossbreed has a body weight of 350 kg, which is an improvement from the 250 kg live weight of the local zebu.

Feed requirement: The crossbreed requires less feed than the Holstein Friesian breed.

CHAPTER 3. CALF REARING

3.0 Introduction

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

3.1 Overview of key aspects in rearing dairy calves.

3.1.1 Management before birth

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

3.1.2 Management at calving

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

3.2 Calf feeding

3.2.1 Colostrum Feeding

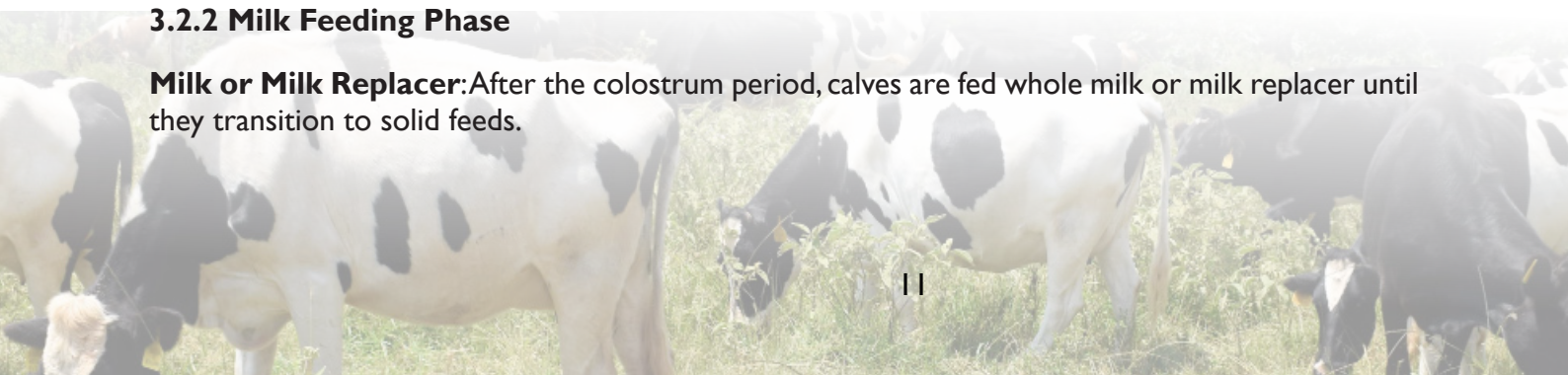
Importance: Colostrum, the first milk from the mother, is rich in antibodies that boost the calf's immunity.

Timing: Calves should receive colostrum within the first 2 hours after birth to maximize antibody absorption, ideally at 10% of the calf's body weight over the first 24 hours.

Quality: Quality colostrum should come from healthy, vaccinated cows. Farmers can test colostrum quality with a colostrometer if available.

3.2.2 Milk Feeding Phase

Milk or Milk Replacer: After the colostrum period, calves are fed whole milk or milk replacer until they transition to solid feeds.



Feeding Schedule: Calves should be fed 2–3 times daily, typically 4–6 liters per day depending on their weight and the farm's feeding schedule.

Feeding Methods: Bucket feeding or nipple bottle feeding are common methods. Nipple feeding is often preferred as it encourages slower milk intake, aiding digestion.

Table 2: Calf feeding before weaning

Calf growth target 600 g/day

Age weeks	Milk liters	Early weaner pellets kg per day	Good quality roughage
1 (0-3 days) (4-7 days)	Colostrum 4	- -	
2	4	handful	handful
3	5	handful	handful
4-5	5	3/4	1 kg
6-9	5	1	1kg
10-11	4	1	adlib
12-13	3	1	adlib
14-15	2	-	adlib
TOTAL	415	70	

Source: KALRO

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

Watering- Calves should be offered fresh water in addition to milk. Lack of drinking waterslows down digestion and development of the rumen, and hence the longer it takes before calves can be safely weaned. Between three weeks and weaning, calves' water consumption usually increases and should be available all the time.

3.2.3 Weaning

Timing: Calves are generally weaned around 8–12 weeks, depending on their health and readiness to eat solid food.

Process: Weaning is gradual, reducing milk while introducing more solid feed, such as calf starter and hay.

Solid Feed Introduction: Calf starter feed (high in protein and energy) should be introduced around the second week to stimulate rumen development.

3.2.4 Calf Housing

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

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

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

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

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

Design:

A calf house floor can be on ground level or raised. If at ground level, the floor should be made of easily cleanable material (e.g. concrete) and should be bedded using straw. The sides can be made of concrete or wooden. The raised pens should have a slatted floor. They are made of timber spaced at 1 inch to allow urine and faeces to fall on the ground. The house should be at least 1 foot from the ground.

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

- Difficulty in feeding and management.
- Disease control is difficult.
- Fights among calves - decreased growth rate.

Calves suckling each other which could lead to ingested hair (tend to form hairballs), blind teats and

removal of disinfectant from umbilical cord.

Feeding the calf

Raised calf pen: Suitable for newborn calves. This type of calf pen is suitable for a zero-grazing unit. It is placed inside the roofed and walled section of the unit. It may be permanent or movable. Individual pens for calves from birth to 2 to 3 months of age are often built with an elevated slatted floor. This floor will ensure that the calf is always dry and clean.

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

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

3.2.5. Health Management

Disease Prevention: Calves are highly susceptible to diseases, so vaccination and deworming schedules are critical. Common diseases include calf scours and respiratory infections.

Dehorning and Disbudding: Removing horns at a young age can prevent injury. It's usually done within the first month using a hot iron or caustic paste.

Navel Care: Immediately after birth, the calf's navel should be disinfected to prevent infections.

3.2.6. Vaccination and Deworming

Vaccination: Calves should be vaccinated based on local veterinary guidelines for diseases like clostridial infections, brucellosis, and others as advised.

Deworming: Regular deworming helps prevent parasites, with the first deworming often recommended around 2–4 weeks of age.

3.2.7. Record-Keeping

Growth Monitoring: Regular weight checks help ensure calves are growing well; typically, healthy calves should gain around 0.5–0.7 kg per day.

Health Records: Keeping track of vaccinations, deworming, illness, and treatment records is essential for effective management and future breeding decisions.

Proper calf rearing practices are essential for building a healthy, productive dairy herd, which directly impacts milk production and overall farm profitability.

3.3 General management Practices

3.3.1 Castration

Male calves are castrated to prevent unwanted mating where male and femalecattle are reared together in one herd. In addition, castrated males are easier to handle and they produce better quality meat. Castration can be done by using an elastrator ring, burdizzo or open castrationusing a knife.

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

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

3.3.2 Dehorning

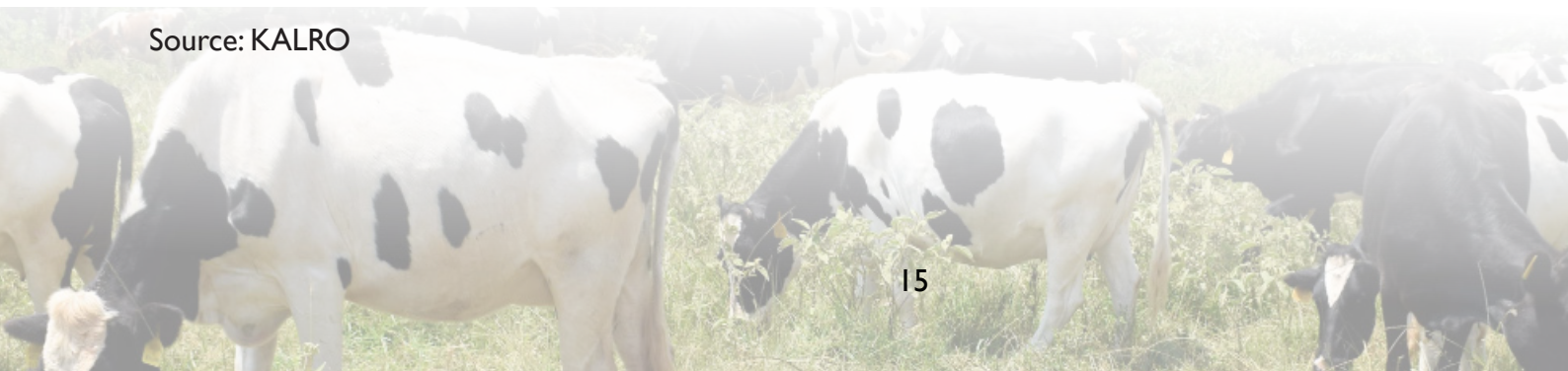
Horned cows are not only dangerous to people working with them, but cause a greatdeal of damage to hides. Dehorning also improves the animal looks. Dehorning can be done by several methods.

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

Table 1: Routine calf and young stock management practices

Practice	Age months	Sex	Method
Identifica-tion	3	Both	Tattooing, Ear tagging,notching, neck straps
Castration	3	Male	Burddizo, rubber ringand by knife
Removal ofextra teats	3	Fe- male	clipping
Disbudding	3	Both	Hot iron

Source: KALRO



3.3.3 Identification

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

Branding

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

Ear marking

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

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

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

3.3.4 Calf Health

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

Common Diseases

Scours (diarrhoea)

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

- Ensuring calves receive adequate colostrum within 6 hours of birth and therefore acquire some natural immunity.
- Feeding the correct amount of milk.
- Early recognition, isolation and treatment of scouring calves
- Maintenance of hygiene and cleanliness of feeding utensils and the environment
- Not rearing calves continually in pens, dirt yards or small paddocks that become heavily contaminated. Paddock rotation will help prevent disease.
- Separation of sick animals to avoid cross infection.
- Close observation of calves at feeding to identify scouring animals as soon as possible for remedial treatment will prevent dehydration and secondary disease leading to chronic ill-thrift and mortality.
- Most scour incidents can be treated simply by:
- Feeding water with salts.
- Avoiding milk for 1-2 feeds. Give fresh water, concentrates and forage.

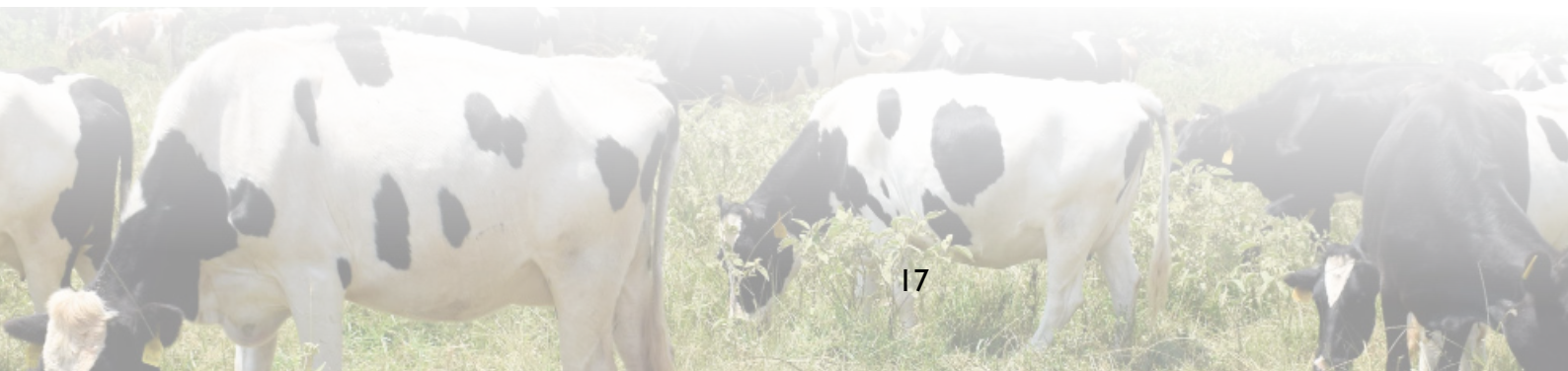
Antibiotics should not be used to treat scours resulting from over feeding or digestive upsets.

Blood scours (mostly caused by coccidia) require veterinary treatment and management changes to improve hygiene.

Pneumonia

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

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



CHAPTER 4: HEIFER REARING

4.0 Introduction

Heifer rearing is the process of managing young female calves until they reach maturity and are ready for breeding. Proper heifer rearing is essential for dairy farming, as it directly impacts milk production, reproduction, and the overall profitability of the herd.

A well-managed dairy farm should have as many calves born every year as there are cows in the herd. Most farmers sell males calves at an early age while the females are reared as dairy replacement heifers for the herd or asheifers for sale. Raising a high number of replacement heifers allows a dairy farmer to:

- Obtain the best replacement heifers through strict selection criteria fromwide selection.
- Expand the dairy herd at low cost (without buying heifers or cows)
- Sell excess heifers to earn income.

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

4.1 Outline of best practices for heifer rearing:

4.1.1 Nutrition and Feeding

Pre-Weaning Period: Initially, heifers receive milk or milk replacer, gradually transitioning to a high-quality calf starter and fresh water by two weeks old to promote rumen development.

Post-Weaning Period: Once weaned (typically between 8–12 weeks), calves should have free access to high-quality hay or pasture and a balanced concentrate feed to support growth.

When feeding heifers, the farmer should aim to:

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

Growth Phases:

3–6 Months: Focus on protein-rich diets to support muscle and frame development. Concentrates should still be provided, especially if pasture quality is low.

6–12 Months: Heifers can graze on good quality pasture and may receive a mineral supplement to support bone growth.

12–15 Months: Gradually prepare for breeding with a balanced diet that maintains body condition without excessive fat, as obesity can affect reproductive health.

Water: Ensure continuous access to clean water to support digestion and growth.

4.1.2. Growth Monitoring

Regular Weighing: Track heifer growth by weighing them monthly or using a weight tape. Target weight gains vary but typically aim for about 0.6–0.8 kg per day.

Target Weights: Heifers should reach about 60-65% of their mature weight by breeding age (typically around 14–15 months) to ensure they are ready for successful breeding.

Body Condition Scoring (BCS): Monitor body condition to avoid extremes of underweight or overweight, as both can negatively impact reproduction.

4.1.3. Housing and Environment

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

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

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

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

4.1.4. Health Management

Vaccinations: Follow a veterinary-recommended vaccination schedule to prevent diseases like brucellosis, clostridial diseases, and respiratory infections.

Parasite Control: Regular deworming and external parasite control are essential, especially if the heifers graze in parasite-prone areas.

Hoof Care: Regular hoof trimming and inspection are important to prevent foot issues, particularly if they are housed in wet or muddy areas.

Disease Monitoring: Observe heifers daily for signs of illness (coughing, diarrhea, lethargy). Early detection and treatment prevent health setbacks and support steady growth.

4.1.5. Breeding Management

Breeding Age: Heifers should be bred when they reach 60-65% of their mature body weight (usually around 14–16 months) to ensure they calve at about 24 months.

Heat Detection: Heifers should be closely monitored for signs of heat (standing to be mounted, restlessness). Using heat detection aids, such as patches or tail paint, can improve detection.

Artificial Insemination (AI) or Natural Service: AI is common in many dairy farms for genetic improvement, but natural mating may be used if AI is not feasible.

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

Table 2: Recommended age and size for breeding and calving for different dairy breeds

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

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

4.1.6. Record Keeping

Individual Health and Growth Records: Record all health interventions, growth data, and breeding history. These records help in making informed decisions and tracking productivity.

Breeding Records: Track breeding dates, pregnancy checks, and estimated calving dates to manage the heifer's transition into the milking herd efficiently.

4.1.7. Transition to Milking Herd

Preparation for Calving: Move pregnant heifers to a maternity pen 2–3 weeks before expected calving. This reduces stress and allows for close monitoring.

Nutrition Adjustments: Provide a diet with adequate calcium, energy, and minerals (Steaming up) to prevent issues like milk fever or ketosis. Once heifers are pregnant, feeding should be adequate to ensure proper developmentto avoid calving problems and poor first-lactation yield. Pregnant heifers may be maintained on good quality forage alone but concentrates should be given if the forageis of low quality.

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

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

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

an effect on calf size, and

an effect on fatness of the dam.

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

Acclimatization: If possible, introduce heifers to the milking parlor before calving to reduce stress and ease their transition to milking.

Properly reared heifers tend to have better health, higher milk yields, and more efficient reproduction, which benefits the farm's overall productivity and sustainability.

CHAPTER 5: FEEDING AND MANAGEMENT OF DAIRY COWS

5.0 Introduction

Proper feeding and management of dairy cows is essential to ensure high milk production, optimal health, and overall farm profitability. The dairy cow is like a as a machine that converts raw materials (feed and water) into milk. The raw materials are mainly plant materials which are not edible by humans but the cow is able to convert into high quality human food.

5.1 Qualities of a good dairy cow

A good dairy cow should exhibit qualities that contribute to high milk production, good health, and efficient management. Here are some key qualities to look for in a dairy cow:

High Milk Production:

A good dairy cow should consistently produce a high volume of milk with a high butterfat and protein content. This can vary by breed but is essential for profitable dairy farming.

Good Body Conformation:

Strong body structure, with well-developed udder, wide and deep chest, straight back, and sturdy legs, supports milk production and longevity.

A large, balanced udder with strong attachments is key to sustaining high milk output over time.

Strong Udder and Teat Structure:

An ideal udder is well-supported and held high to avoid injury or contamination, with teats that are easy to milk but not too large.

Good Fertility:

Fertility is essential for the cow to have a consistent calving schedule, which supports regular milk production cycles.

Calm and Docile Temperament:

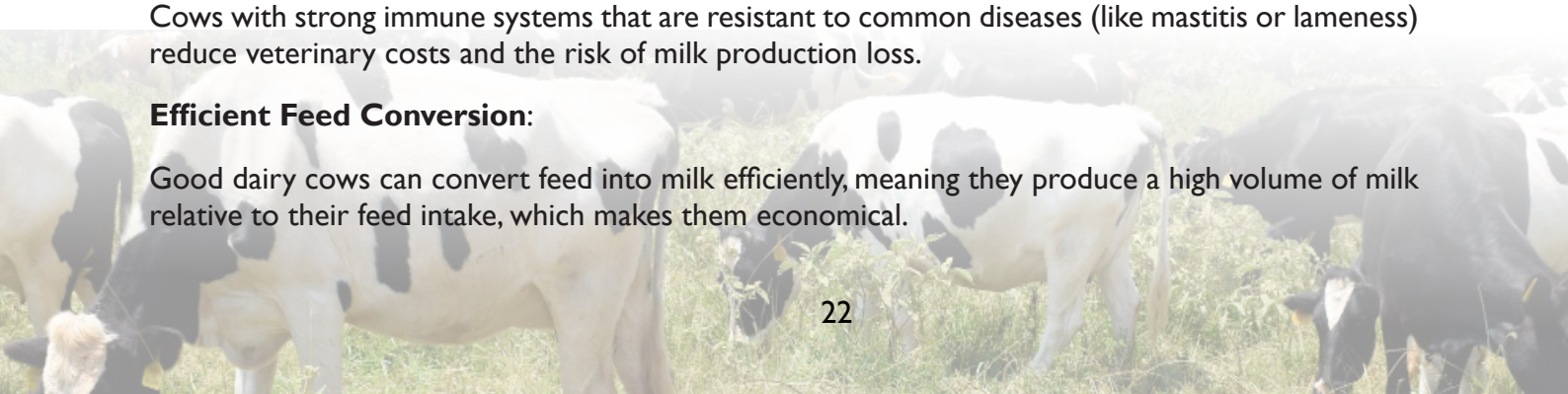
A good dairy cow should be calm and manageable, which reduces stress for both the animal and the farmer. This contributes to improved health and productivity.

Disease Resistance:

Cows with strong immune systems that are resistant to common diseases (like mastitis or lameness) reduce veterinary costs and the risk of milk production loss.

Efficient Feed Conversion:

Good dairy cows can convert feed into milk efficiently, meaning they produce a high volume of milk relative to their feed intake, which makes them economical.



Longevity:

Dairy cows that have longer productive lifespans reduce the need for frequent replacements, which is beneficial for farm economics.

Easy Calving:

Good dairy cows should have a history or genetic predisposition for easy calving, reducing health risks for both the mother and the calf.

Strong Feet and Legs:

Strong feet and legs are crucial for supporting the weight of high milk production and for reducing lameness, allowing the cow to access feed and water easily.

Adaptability to Environment:

Good dairy cows should thrive in the specific environmental and management conditions they're raised in, whether pasture-based or confined, and adapt well to climate conditions.

Consistent Milk Yield Throughout Lactation:

Instead of peaking and dropping sharply, a good dairy cow should maintain a steady milk yield through her lactation period.

When selecting dairy cows, assessing these qualities can help ensure they will perform well and contribute to the productivity and efficiency of the herd.

5.2 Feeding

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

5.2.1 Nutritional requirements

Proper feeding is essential to ensure animals receive adequate nutrients for maintenance and production, and remain healthy and in good body condition. Dairy cattle must eat a balanced diet. Too little (or poor-quality feed) results in thinanimals that cannot resist disease while giving too much feed is wasteful and does not make economic sense. Lack of essential nutrients will result in ill-health, failureto reach full production potential and sometimes death. For cattle, the basic types of ingredients needed are shown in Table 3 below.

Macro ingredients. Energy supplies the body's fuel allowing the animal to move, keep warm, stay alive and be productive. Energy feeds are the mainpart of the diet. Protein helps young animals to grow and develop strong muscles and enables cows to produce healthy calves and adequate milk.

Micro ingredients. Minerals and vitamins are required in small amounts and fulfil a variety of functions, including forming strong bones and maintaining thereproductive system.

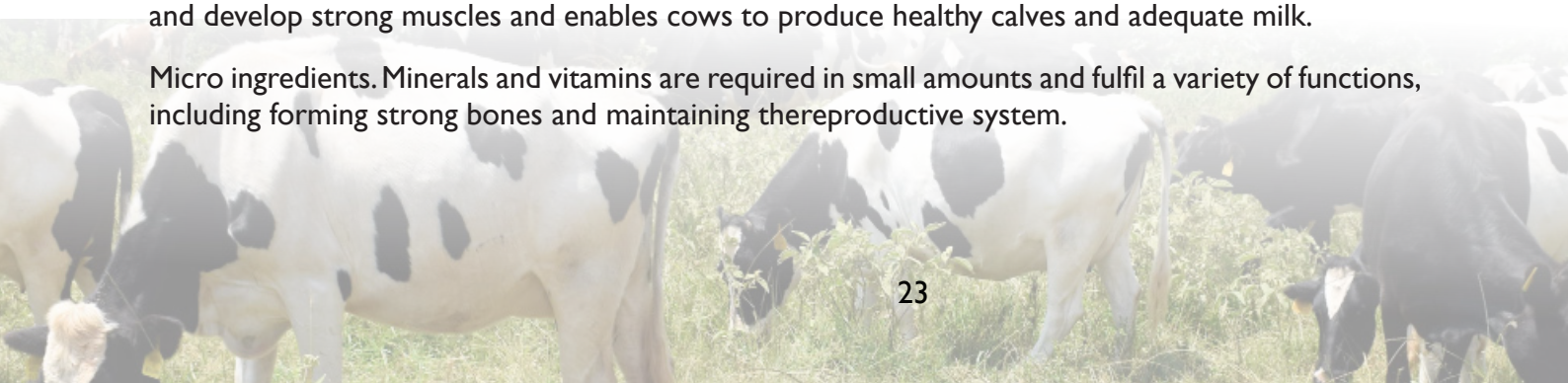


Table 3. Feeds supplying different types of nutrients

Type of nutrients Cattle diets

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

5.2.2 Nutrient requirements

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

Here's a table summarizing the crude protein (CP) needs of lactating dairy cows at various milk production levels. Protein requirements increase with milk yield due to the greater demand for amino acids needed for milk synthesis.

Milk Production (kg/ day)	Body Weight (kg)	Crude Protein Requirement (% of Dry Matter)	Crude Protein Intake (kg/day)
15	500	13-14%	1.8-2.0
20	500	15-16%	2.5-2.8
25	600	16-17%	3.3-3.6
30	600	17-18%	4.0-4.3
35	650	18-19%	4.8-5.1
40	700	19-20%	5.5-5.8

Table 4 showing the crude protein (CP) needs of lactating dairy cows at various milk production levels Source: (target 10 1999)

Notes:

Milk Production: The amount of milk produced daily by the cow.

Body Weight: Average body weight of the cow, as larger cows generally require slightly more protein.

Crude Protein Requirement (% of Dry Matter): This is the percent of total dry matter intake that should be crude protein.

Crude Protein Intake (kg/day): This is the daily crude protein intake requirement based on typical dry matter intake for that production level.

These values may vary slightly based on factors like stage of lactation, breed, body condition, and environmental conditions.

5.2.3 Types of feed

Balanced diets for cattle are made of the following:

Bulk feeds

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

Supplementary feeds

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

Minerals

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

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

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

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

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

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

Vitamins

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

Water

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

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

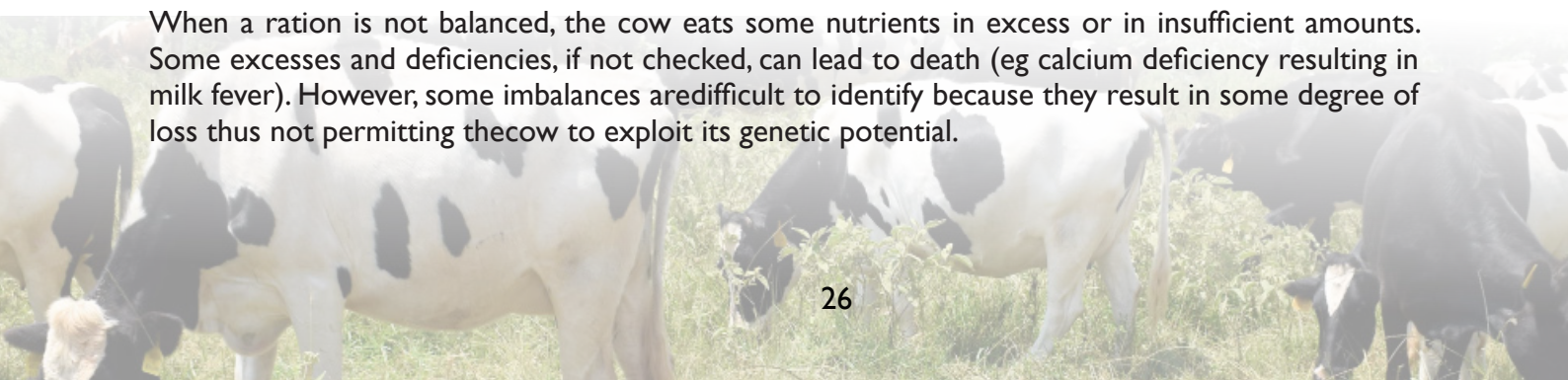
5.2.4 Balanced Ration

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

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

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

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



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

5.2.5 Total Mixed Rations (TMR)

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

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

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

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

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

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

Use of TMR improves milk fat test, minimises digestive upsets, eliminates need for minerals supplements, allows use of less palatable ingredients and eliminates need for concentrate feeding at milking.

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

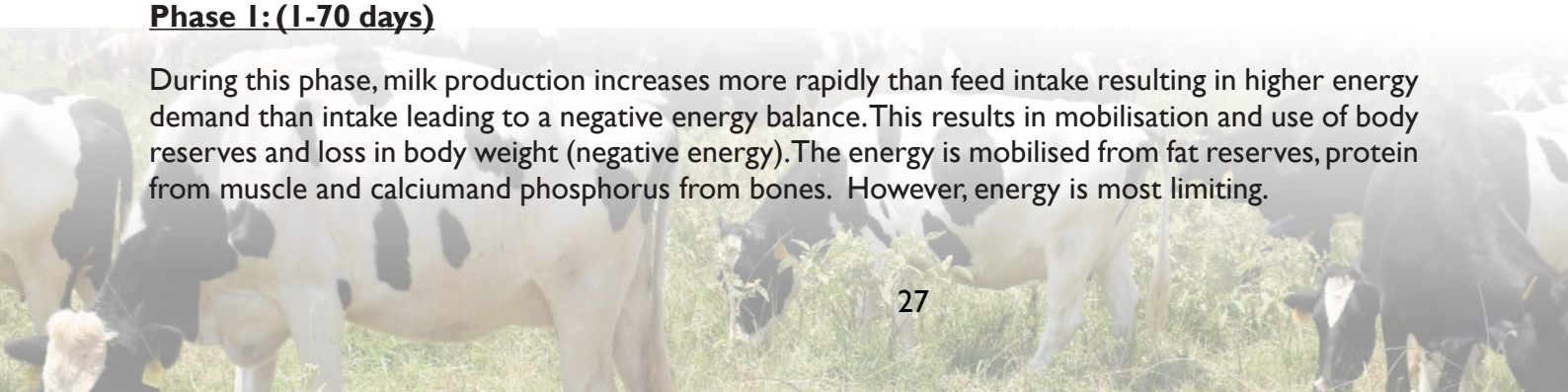
5.2.6 Practical feeding

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

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

Phase 1: (1-70 days)

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



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

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

If excessive concentrates are added too rapidly (non-accustomed cows) to the ration, they can lead to digestive disturbances (rumen acidosis, loss of appetite, reduced milk production, low milk fat content). It is therefore recommended that concentrates should be limited to 50-60% of diet dry matter, the rest being forage to ensure rumination (proper function of the rumen). If high amounts of concentrate arefed during this time buffers (chemicals that reduce the acid in the rumen andavailable commercially) can be helpful.

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

Phase 2: (70-150ds)

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

Phase 3: (151-305ds)

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

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

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

This extra concentrate (steaming) enables the cow to store some reserves to be used in early lactation and to adapt rumen microbial population to digest concentrates in early lactation to minimise digestive disturbances. During this phase the cow can be fed good quality forage or poor quality supplemented with concentrate to provide 12% CP. The cows should not be fed high amounts

of concentrate to avoid over conditioning. If the diet is rich in energy, intake should be limited. Bulky roughages can be fed to help increase rumen size to accommodate more feed at parturition. The amount of calcium and phosphorous fed should be restricted during the dry period to 0.4% and 0.25% to minimise incidences of milk fever.

Guidelines for concentrate feeding

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

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

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

The example below is one of the many guidelines.

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

Up to 7 kg of milk comes from the basal forage diet

For every extra 1.5 kg milk above 7 kg, give 1 kg dairy meal

Challenge feeding:

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

Note:

Since underfeeding in early lactation can result in reduced milk production throughout lactation and delayed coming on heat, it is advisable for farmers who have limited resources to buy concentrates

to feed more in early lactation and none towards the end of lactation.

5.2.7 Feed conservation

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

Haymaking

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

Harvesting and curing

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

Baling hay

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

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

Characteristics of good-quality hay

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

- be leafy and greenish in colour
- have no foreign material mixed with it
- have no smell

Silage

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

- Contain an adequate level of fermentable sugars in the form of water-solublecarbohydrates;
- Have dry matter content in the fresh crop above 20%; and
- Possess a physical structure that will allow it to compact readily in the silo after harvesting

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

- Field wilting, to reduce moisture
- Fine chopping, generally 20–25 mm preferred to allow compaction
- Use of additives, to increase soluble carbohydrates

Harvesting stages

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

Types of silos

A silo is an airtight place or receptacle for preserving green feed for future feeding on the farm. Silos can be either underground or above ground, the qualification being that the silo must allow compaction and be air tight. Five types are described here: tube, pit, above-ground, trench and tower.

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

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

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

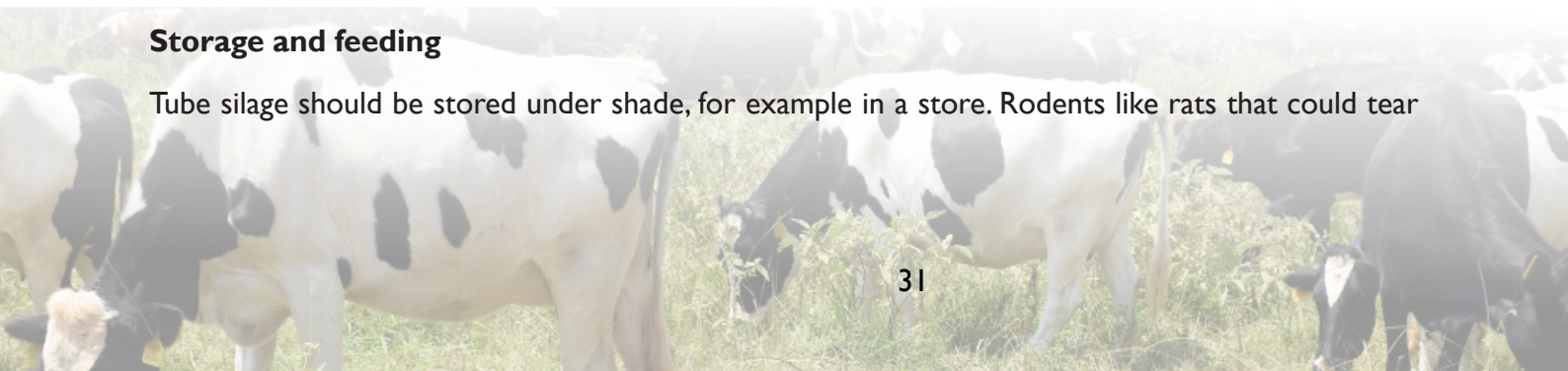
Tower silos are cylindrical and made above-ground. They are 10 m or more inheight and 3 m or more in diameter. Tower silos containing silage are usually unloaded from the top of the pile. An advantage of tower silos is that the silage tends to pack well due to its own weight, except for the top few feet.

Qualities of good silage

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

Storage and feeding

Tube silage should be stored under shade, for example in a store. Rodents like rats that could tear



the tube need to be controlled. When feeding, open the tube and scoop a layer and remember to re-tie without trapping air inside. When feeding from the pit, scoop in layers and cover after removing the day's ration, making sure thepit is air tight. Drainage from the top should be guided to avoid rainwater draininginto the pit. When feeding from the above-ground method, open from the lower side of the slant,remove the amount you need for the day and re-cover it without trapping air inside. To avoid off-flavours in milk, feed silage to milking cows after milking, not before, or feed at least 2 hours before milking.

Losses

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

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

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

Silage additives

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

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

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

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

5.3 General management of dairy cows

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

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

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

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

Table 5: A breakdown of the different periods in a lactating dairy cow's cycle, typically represented in a lactation curve chart:

Period	Days in Lactation	Description
Early Lactation	0-100 days	- **Peak Milk Production**: Milk production rapidly increases, reaching peak around 45-60 days.
		- **Negative Energy Balance**: Energy demand is high, leading to body weight loss as feed intake lags behind needs.
Mid Lactation	100-200 days	- **Milk Production Decline**: Milk output gradually declines after peak production.
		- **Energy Balance Restored**: Feed intake matches energy requirements, stabilizing body condition.
Late Lactation	200-305 days	- **Further Decline in Milk Production**: Milk yield continues to drop, and feed intake reduces accordingly.
		- **Body Condition Rebuilding**: Cows regain body condition in preparation for the dry period.
Dry Period	Last 60 days	- **No Milk Production**: Rest period allowing udder recovery and preparation for the next lactation cycle.
		- **Transition Diet**: Begin transition diet 2-3 weeks before calving to support rumen adaptation and fetal growth.

Service period: From calving to successful conception

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

5.3.1 Heat detection:

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

Several methods are used to detect heat. The most commonly used by farmers are behavioural signs and physical changes. Heat detection is critical in dairy herd management, as it helps identify the optimal time for breeding, maximizing conception rates, and maintaining an efficient calving interval. Here are the key signs to detect heat in dairy cows:

Table 6: showing heat detection score

Behaviour	Points
Mucous vaginal discharge	3
Cajoling	3
Restlessness	5
Being mounted but not standing	10
Sniffing vagina of other cow	10
Resting with chin on other cow	15
Mounting (or attempting to mount) other cow	35
Mounting head side of other cow	45
Standing heat	100

Scoring system with primary and secondary oestrus behaviours (adapted from Van Eerdenburg *et al*., 1996). This scoring system is cumulative during a 24-hour period. When observed 12 times per day for 30 minutes and a score of 100 points is reached, the animal is considered to be in heat and can be inseminated if desired. When the cows are observed two or three times per day for 30 minutes, a threshold of 50 points can be applied.

How to improve breeding performance

Serve cows 50 to 75 days after calving.

After insemination, check 19 to 21 days later for any heat signs.

Carry out pregnancy diagnosis six to eight weeks after the last insemination.

Maintain good nutrition with balanced rations and adequate mineral supplementation for good fertility.

5.3.4 Breeding methods

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

Natural service:

This is where the cow is taken to a bull and left for some time for the bull to serve.The advantages of this method are:

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

Natural service has the following disadvantages:

- Rearing a bull is not economical especially to a small holder farmer
- There is risk of spreading breeding diseases.
- There is risk of inbreeding if the bull is not changed frequently

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

Increasing the chances of conception through natural service:

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

Natural mating can be done in two ways:

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

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

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

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

Artificial Insemination

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

Benefits of Artificial Insemination

Prevention of venereal diseases

Indefinite preservation of genetic materials of low cost enabling wide testingand selection of bulls

Enhances genetic progress as best bulls are used widely nationally andinternationally

Small scale farmers through AI can access good bulls cheaply

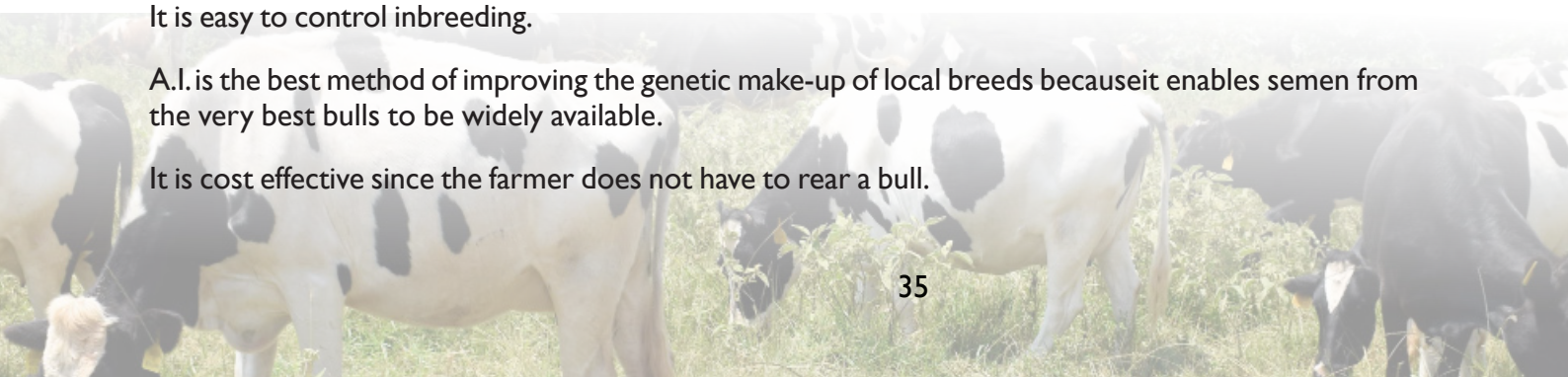
One is able to select the bull of interest.

When handled properly, there is no chance of spread of breeding diseases.

It is easy to control inbreeding.

A.I. is the best method of improving the genetic make-up of local breeds becauseit enables semen from the very best bulls to be widely available.

It is cost effective since the farmer does not have to rear a bull.



Disadvantages of AI

It requires very accurate heat detection and proper timing of insemination forgreater chances of conception.

The inseminator must be trained on the technique.

It requires high investment in equipment.

5.3.5 Factors affecting rate of conception:

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

Technique

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

Nutritional factors.

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

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

Normal health of female genital tract.

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

Indicators of infertility

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

Abnormal oestrus: Absence of heat, irregular heat, silent heat, constant heat(nymphomania)

Embryonic or foetal death: Abortions, mummified foetus (foetus dying in uterus and becoming mummified)

Outbreak of reproductive diseases e.g. brucellosis or trichomoniasis

Fertility indices

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

be used.

Calving interval:

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

Conception rate (number of animals conceiving as percent of number served)70% after 1st service

80% after 2nd service

>90% after 3rd service

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

Table 7: Desired heard composition in dairy management.

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

Estrus synchronization

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

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

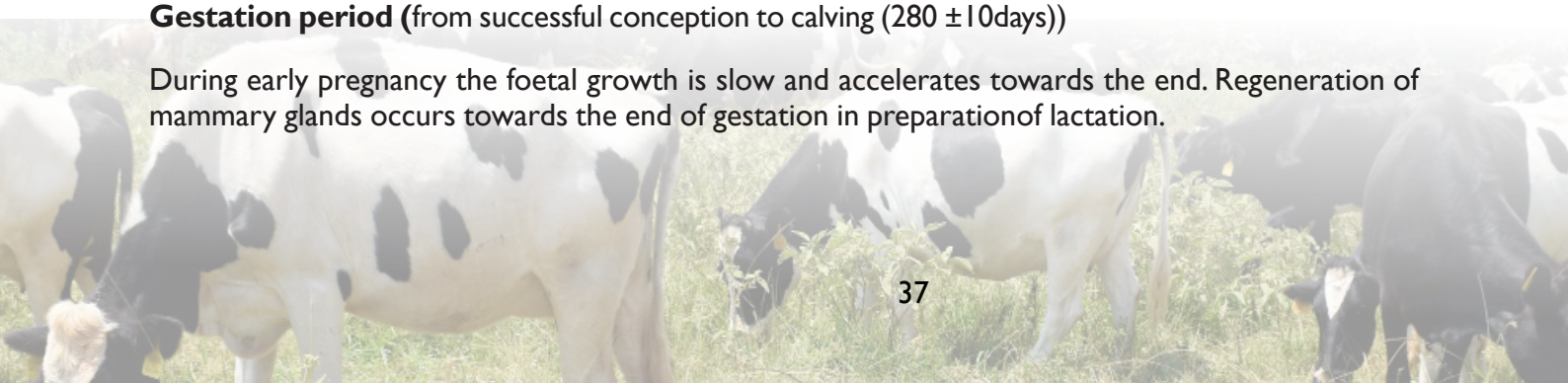
Embryo transfer

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

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

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

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



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

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

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

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

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

5.3.6 Factors affecting milk production

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

Animal factors:

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

Parity (age)- Mature cows (>6 yrs) produce 25% more milk than young cows. First lactation yields 25% less than 4th lactation. After peak yield there is a decline, as cow grows old. As milk yield increases with age, the herd should have both young animals(for genetic improvement) and old cows for higher milk production.

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

Oestrus -Milk production drops the day the cow is on heat or day following heat. Pregnancy- By the 4th to 5th month of pregnancy, total milk production of gestatingcows declines faster than that of non- pregnant cows.

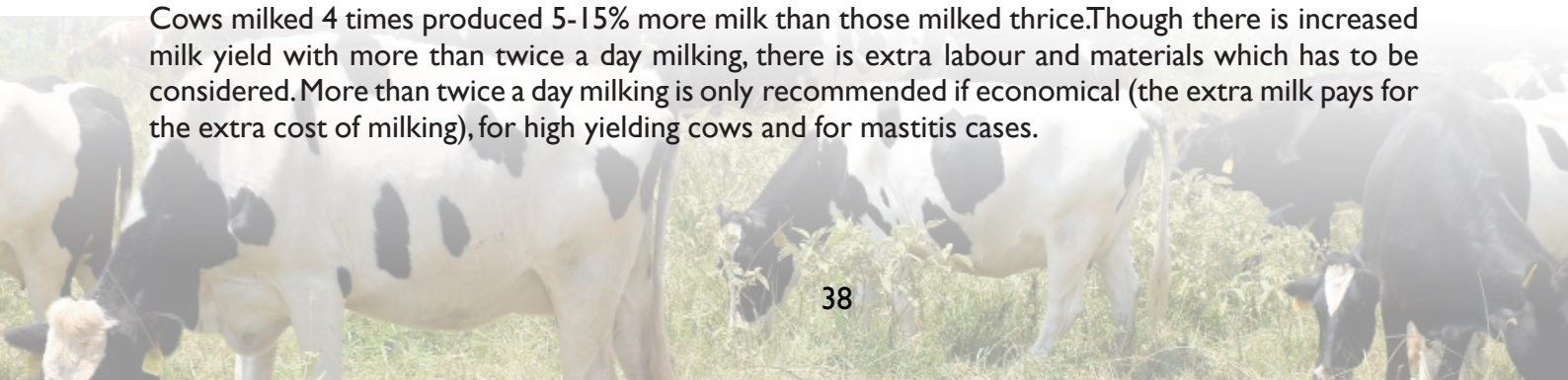
Size- Bigger cows will produce more milk than smaller cows of similar breed.

Environmental factors:

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

Length of dry period - A short dry period (<60d) usually results in lower milk production.Condition of cow at calving - Excessively thin or fat cows produce less milk.

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



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

Disease- Diseases like mastitis, ketosis, milk fever and others affect milk production. Change of milker and milking routine will lower milk yield.

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

Dry period (drying to calving: 60days)

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

Ways of drying cows:

The feed intake should be reduce to maintenance level by withdrawing the concentrate and for high yielder, feed on low quality forages (eg straw) to reducemilk synthesis.

For low yielding cows, just stop milking. Pressure builds up in udder and milk production is cut off.

If cow is a high yielder, practice intermittent milking i.e. skip some milking times(milk only in mornings) so as to reduce milk synthesis due to pressure build up inudder while reducing feed intake.

Water can be temporarily withdrawn for very high yielders to reduce milk synthesis.

After cessation of milking, treat (infuse) all the quarters with long acting antibiotics to prevent development of mastitis.

Reasons of drying

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

Build up body reserves to meet next production - if a cow is not dried in time, itaffects the milk production during the next lactation.

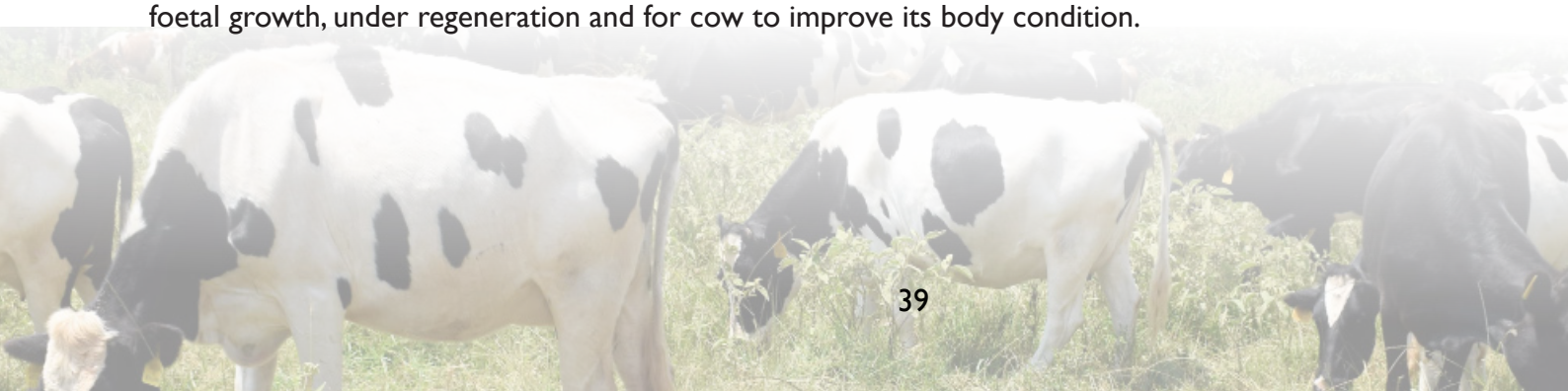
Allow animal to regenerate alveolar tissue (milk synthesizing tissue) which mighthave atrophied during the lactation period.

Save nutrients for the fast growing foetus. During the last phase of pregnancy, thecalf grows at a fast rate and drying saves nutrients for its growth.

Steaming up

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

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



CHAPTER 6: CLEAN MILK PRODUCTION

6.0 Introduction

Milk is a nutrient-rich liquid produced by mammals, primarily to nourish their young. In dairy farming, milk is harvested from cows and other animals for human consumption. Here's a closer look at its composition, nutritional value, and physical characteristics.

6.1 Composition of Milk

Water: Milk is approximately 87% water, making it a hydrating drink while carrying dissolved and suspended nutrients.

Carbohydrates: Lactose is the primary carbohydrate in milk, providing a mildly sweet flavor. It is essential for energy and plays a role in calcium absorption.

Proteins: Milk contains two major proteins:

Casein: The dominant protein, responsible for the white color of milk and essential in cheese-making.

Whey: A high-quality, easily digestible protein that supports muscle growth and immune function.

Fats: Milk fat varies depending on the type (whole, low-fat, skim). It provides essential fatty acids, fat-soluble vitamins (A, D, E, K), and contributes to the creamy texture.

Vitamins and Minerals: Milk is a good source of calcium, potassium, phosphorus, and vitamins B12 and riboflavin. Fortified milk often contains added vitamin D to aid calcium absorption.

6.2 Nutritional Value

Calcium: Milk is an excellent source of calcium, essential for bone health and muscle function.

Protein: The high-quality protein in milk supports growth, tissue repair, and overall health.

Vitamins: Vitamin D (in fortified milk) and vitamin B12 support bone health and red blood cell production, while riboflavin aids in energy metabolism.

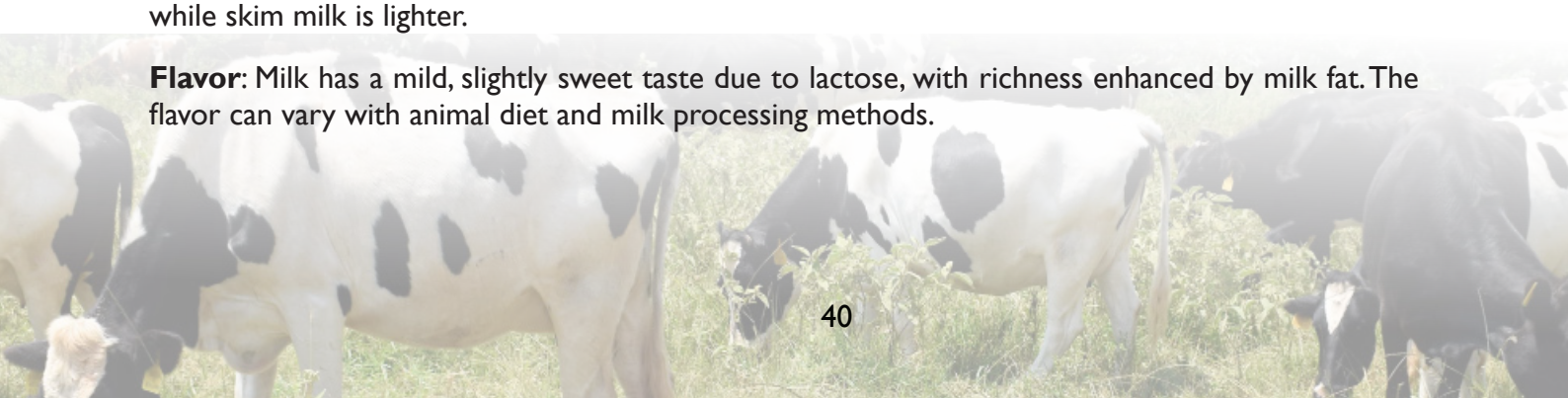
Fats: Whole milk provides essential fatty acids and is a source of energy, while low-fat and skim milk offer lower-calorie options.

6.3 Physical Characteristics

Color: The white color of milk is due to the reflection of light by suspended casein micelles and fat globules.

Texture: Milk has a smooth, creamy texture, which varies with fat content. Whole milk is richer, while skim milk is lighter.

Flavor: Milk has a mild, slightly sweet taste due to lactose, with richness enhanced by milk fat. The flavor can vary with animal diet and milk processing methods.



6.4 Types of Milk (Processing and Fat Content)

Whole Milk: Contains about 3.25% fat and is the closest to its natural state after pasteurization.

Low-fat Milk: Typically contains 1-2% fat.

Skim Milk: Contains almost no fat, making it a lower-calorie option.

Pasteurized Milk: Heat-treated to kill harmful bacteria without altering nutritional value.

Homogenized Milk: Mechanically treated to break up fat globules, ensuring an even consistency without cream separation.

6.5 Health Benefits of Milk

- Supports bone and dental health due to calcium and vitamin D.
- Provides a complete protein source, ideal for muscle and tissue repair.
- Offers hydration with additional nutrients.
- May lower blood pressure due to potassium content.
- Overall, milk is a versatile and nutritious food that can be consumed as a beverage, used in cooking, or processed into dairy products like cheese, yogurt, butter, and cream.

Milking- Milking is the process of extracting milk from dairy animals. Proper milking practices are essential to ensure milk quality, animal health, and productivity. Here's a detailed guide on milking. At the farm this startswith ensuring the cow to be milked is healthy.

6.6 Milking Methods

Hand Milking: Traditionally, milk is extracted manually by squeezing the teats. This method is mostly used in small-scale farming or in rural areas.

Machine Milking: The most common method in commercial dairies, where milking machines use vacuum suction to extract milk from multiple cows at once. It is faster, more efficient, and minimizes human contact, reducing the risk of contamination.

Robotic Milking Systems: Automated milking robots allow cows to be milked on demand. The cow enters the machine voluntarily, and the robot attaches the milking cups, extracts milk, and records production data for each cow.

Milking Routine

Udder Preparation: Proper udder preparation is essential for both milk quality and mastitis prevention.

Cleaning: The udder and teats are washed or wiped to remove dirt and bacteria. A pre-dip (disinfectant solution) may also be applied and wiped off after 30 seconds.

Forestripping: A small amount of milk is manually expressed from each teat before attaching the milking machine. This helps stimulate milk letdown and checks for signs of mastitis.

Attaching the Milking Unit: Once the udder is prepared, the milking unit is attached to the teats. The vacuum suction gently draws the milk out.

Milking Duration: Each cow typically takes 5-10 minutes to be milked. The machine automatically senses when milk flow decreases, and then it releases the cups.

Post-Milking Teat Dipping: After milking, teats are dipped in an antiseptic solution to reduce bacterial contamination and prevent mastitis.

Milking Frequency

Twice a Day: Most commercial dairies milk cows twice a day (every 12 hours), which is the standard practice.

Three Times a Day: Increasing frequency to three times a day can improve milk yield by 10-15%, though it requires more labor and resources.

Robotic Milking (Multiple Times): Cows milked with robotic systems may milk themselves 2-4 times daily, based on individual preference and productivity.

Importance of Milking Hygiene

Cleanliness during milking is crucial to prevent bacterial contamination, ensuring high milk quality and cow health.

Clean and sanitize milking equipment before and after each use to avoid the spread of pathogens.

Proper cow bedding and udder care help reduce the incidence of mastitis and other infections.

Milk Letdown and Oxytocin Release

The milk letdown reflex is controlled by the hormone oxytocin, released in response to udder stimulation.

It's important to minimize stress in cows before and during milking, as stress inhibits oxytocin and can delay or reduce milk letdown.

Gentle handling, a consistent milking routine, and a calm environment support effective letdown and maximize milk production.

Milk Collection and Storage

After extraction, milk is filtered to remove impurities and rapidly cooled to around 4°C to prevent bacterial growth.

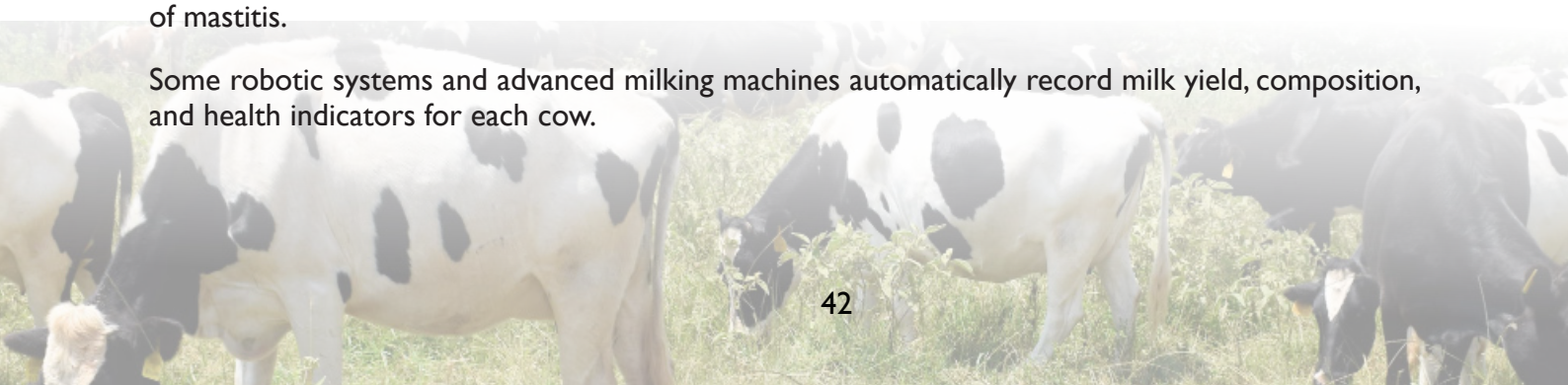
In commercial dairies, milk is stored in bulk tanks until transported to processing plants.

Milking Health and Monitoring

Regular monitoring of udder health, milk quality, and cow comfort is essential.

Technologies like somatic cell count (SCC) analysis help monitor udder health and detect early signs of mastitis.

Some robotic systems and advanced milking machines automatically record milk yield, composition, and health indicators for each cow.



Mastitis Prevention

Mastitis, an infection of the udder, is one of the most common health issues in dairy cows and affects milk quality and yield.

Good milking hygiene, proper udder care, and post-milking teat disinfection significantly reduce mastitis risk.

Regular veterinary checks and prompt treatment of infections are essential for herd health.

Advantages of Proper Milking Practices

Increased Milk Yield: A consistent and comfortable routine supports higher milk production.

Better Milk Quality: Clean, stress-free milking reduces bacterial contamination and improves milk taste and shelf life.

Animal Health and Welfare: Proper milking prevents udder infections, promotes comfort, and supports overall cow health.

Effective milking practices, good cow handling, and consistent routines play a critical role in ensuring high-quality milk, maintaining cow health, and improving farm profitability.

6.7 The Dairy Cow

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

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

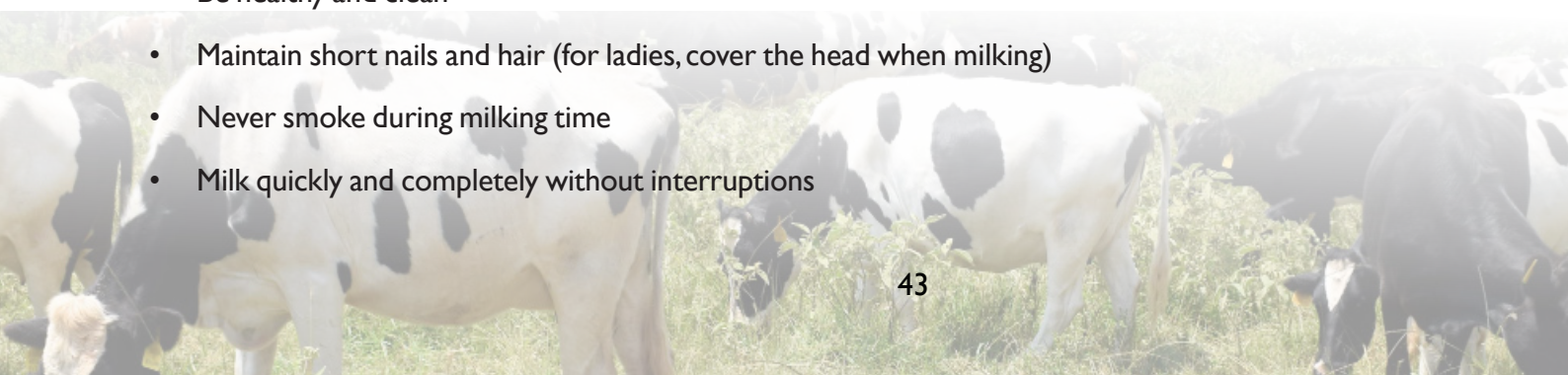
Farmers are encouraged to vaccinate their animals against brucellosis.Animals should also be checked periodically for all types of contagious diseases and treated promptly in case they are infected.

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

6.8 The milker

Should:

- Be healthy and clean
- Maintain short nails and hair (for ladies, cover the head when milking)
- Never smoke during milking time
- Milk quickly and completely without interruptions



6.9 The environment of a dairy Cow

A milking shed (parlor) which can be permanent or movable should be constructed.It should be located away from any smells.

The floor of shed should be clean and dry and if possible have a cement floor forease of cleaning.

The shed should be cleaned after every milking and animals kept off outsidemilking time.

Equipment

Use seamless aluminum or stainless steel cans for milking and storing milk. Plasticcontainer is difficult to clean.

Clean utensils immediately after milking or after emptying milk: rinse with cold water, scrub with a brush using hot water with detergent then rinse with cold water.Place upside down on a rack and dry in the sun.

Store utensils in a safe, clean and well ventilated room.

6.10 Milking

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

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

6.10.1 Practical aspects of milking:

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

Steps:

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

Feed the cow it's production ration (this is optional depending on the feedingsystem) - This calms the animal and stimulates milk letdown.

Restrain animal - tie hind legs above hock joint in the form of a figure 8.A loose knot should be used to safeguard both animal and man (applicable onlyfor hand milking).

Wash hands with soap and clean water before milking. Dry hands with towel.

Test for mastitis using a strip cup - strip first few rays of milk into strip cup from each quarter and observe for any abnormalities. If mastitis is detected,the cow should be milked last.

Wash udder with warm clean water with disinfectant using a clean towel.Warm water also

stimulates milk let down. Dry udder using a dry towel.

Apply milking jelly - prevents cracking of teats and eases milking (for handmilking only)

Milk quickly and completely by squeezing the teat, do not pull. Milking eachcow should take 7–10 minutes at most.

Use clean containers for milking.

After milking: Strip the animal - getting last drops of milk from udder to avoidincomplete milking (can lead to mastitis).

After milking dip the teats in a teat dip (disinfectant to ensure that bacteria donot gain entry through the teat sphincter which is loose immediately after milking).

6.10.2 Milk Handling

Proper handling of milk is essential to maintain its quality, safety, and shelf life. Here's a step-by-step guide on the best practices for handling milk from the time it leaves the cow to its storage or transport:

1. Immediate Cooling

Rapid Cooling: After milking, milk should be cooled as quickly as possible to around 4°C (39°F) within two hours. Quick cooling slows bacterial growth, which can degrade milk quality.

Bulk Milk Coolers: Most dairy farms use bulk milk coolers or tanks to rapidly bring milk to the desired temperature and store it until it's collected for transport.

2. Filtration and Clarification

Filtration: Milk should be filtered immediately after milking to remove any impurities, such as dust, hair, or other foreign particles. Fine stainless-steel or single-use filters are typically used for this process.

Clarification: Larger operations may use centrifugal clarifiers to remove smaller impurities and somatic cells, further improving milk quality.

3. Storage in Bulk Tanks

Sanitary Storage: Bulk tanks are designed to keep milk at a constant temperature of 4°C. These tanks are stainless steel, easy to clean, and equipped with agitators that maintain an even temperature and prevent cream separation.

Tank Hygiene: Tanks should be thoroughly cleaned after each batch to prevent contamination. A cleaning schedule, typically daily or after each milking, is important for maintaining quality.

4. Milk Quality Testing

Routine Testing: Conduct tests for somatic cell count (SCC), bacterial count, temperature, and composition (fat, protein, lactose). High-quality milk has low SCC and bacterial counts.

Adulteration Tests: Routine checks for adulterants, such as water, antibiotics, or chemical residues, ensure milk meets safety and quality standards.

5. Sanitization and Equipment Maintenance

Clean Equipment: All milking equipment, pipes, and storage tanks must be cleaned and sanitized daily or after each milking session to prevent bacterial growth.

Regular Maintenance: Milking machines, coolers, and agitators require routine inspection and maintenance to ensure efficiency and prevent breakdowns that could impact milk quality.

6. Minimizing Contamination Risks

Personal Hygiene: Milking personnel should maintain high standards of hygiene, including clean clothing and hands, and should avoid contact with milk to prevent contamination.

Avoid Cross-Contamination: Keep sick animals or those on antibiotics separate from the herd. Antibiotic-treated milk must be discarded and not added to the bulk tank to comply with safety regulations.

7. Transport to Processing Facilities

Timely Collection: In most commercial operations, milk is collected every 24-48 hours by insulated, refrigerated milk tankers to ensure it remains cool and fresh.

Temperature Control: Milk must stay below 4°C during transport to prevent bacterial growth. Milk tankers are designed with stainless steel interiors and insulated walls to maintain the desired temperature.

8. Record-Keeping

Detailed Records: Keep records of milk production, quality test results, storage temperatures, cleaning schedules, and milk transport to identify issues, maintain standards, and trace any quality issues.

9. Regulatory Compliance

Food Safety Standards: Adhere to local and national standards for milk handling and storage. This includes following regulations on cleanliness, pasteurization (if required), and antibiotic testing.

Traceability: Ensure traceability by documenting each stage of milk handling, which is essential for quality control and safety.

10. Maintaining Cleanliness at Every Stage

Udder and Teat Cleanliness: Keep the udder and teats clean before milking to reduce bacterial contamination.

Sanitized Environment: Milking parlors should be kept clean and dry to prevent contamination from manure, dust, or other farm debris.

Importance of Proper Milk Handling

Maintains Milk Quality: Prevents off-flavors, bacterial growth, and spoilage, ensuring milk is fresh and safe for consumption.

Extends Shelf Life: Proper cooling, filtering, and handling reduce spoilage, allowing milk to last longer.

Ensures Consumer Safety: Strict handling minimizes risks of foodborne illnesses, contributing to

consumer trust and compliance with health regulations.

Proper handling from farm to processing facility ensures milk remains high-quality, safe, and nutritious for consumption.

6.11 Basic milk quality tests

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

Sight-and-smell (organoleptic) test

Clot-on-boiling test

Alcohol test

Lactometer test

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

Organoleptic test

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

Procedure

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

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

Type of feed or atmospheric taint (e.g. feeding silage or brewer's waste too close to milking time)

Cows in late lactation or in some cows when on heat or soon after conception (due to hormonal changes)

Bacterial taints (from cows with mastitis)

Chemical taints or discolouring (may be due to equipment not rinsed properly)

Advanced acidification or souring (milk that is fermenting)

Marked separation of fat may be caused by:

Milk previously chilled and subjected to excessive shaking during transportation

Adulteration with other solids (may also show as sediments or particles)

Boiling, if milk fat is hardened

Clot-on-boiling test

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

Procedure

Boil a small amount of milk for a few seconds in a spoon or other suitablecontainer.

Observe immediately for clotting.

The milk will be rejected if there is visible clotting, coagulation or precipitation

Alcohol test

The test is quick and simple. The specific type of alcohol used is known as "ethanol". This test is more sensitive to lower levels of acidity and can therefore detect bad milkthat may have passed the previous two tests. It also detects milk that has kept for longwithout cooling, colostrum or milk from a cow with mastitis. Because this test is quitesensitive, milk that passes this test can keep for some hours (at least two hours) before it goes bad.

Procedure

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

Lactometer test

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

Procedure

Leave the milk to cool at room temperature for at least 30 minutes and ensure itstemperature is about

20°C.

Stir the milk sample and pour it gently into a 200 ml measuring cylinder or anycontainer deeper than the length of the lactometer.

Let the lactometer sink slowly into the milk.

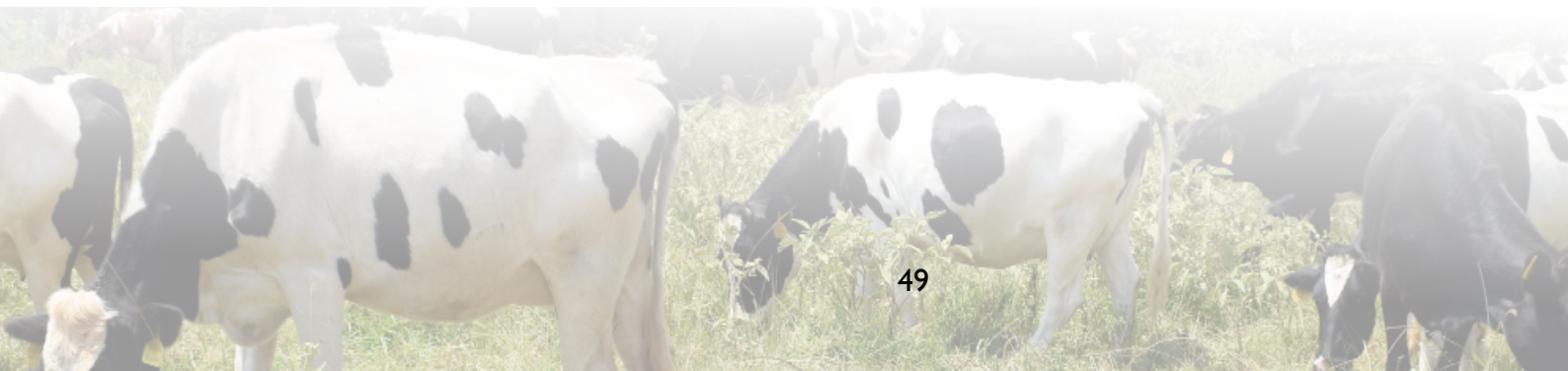
Take the lactometer reading just above the surface of the milk.

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

For each °C above the calibration temperature, add 0.2 lactometer "degrees" (°L) to the observed lactometer reading.

For each °C below calibration temperature, subtract 0.2 lactometer "degrees" (°L)from the observed lactometer reading.

Note: These calculations are done on the lactometer readings (e.g. 29 instead ofthe true density of 1.029 g/ml).



CHAPTER 7: DAIRY CATTLE HOUSING

7.0 Introduction

The housing requirements of dairy cows are essential for their health, productivity, and overall welfare. Good housing provides shelter, comfort, and ease of movement and includes design features that allow effective waste management, ventilation, feeding, and milking. Here's a breakdown of the general housing requirements for dairy cows:

1. Space Requirements

Individual Space: Each cow should have enough space to lie down, stand up, and move freely without interference. Generally:

Stall Width: About 1.2 to 1.3 meters (4-4.3 feet) for comfortable lying.

Stall Length: 2.3 to 2.5 meters (7.5-8 feet) to accommodate body length.

Group Housing: If cows are housed in a group system, 7.5-9 square meters (80-100 square feet) per cow is recommended to allow freedom of movement.

2. Ventilation and Air Quality

Natural Ventilation: Proper airflow is essential to remove moisture, ammonia, and heat, especially in hot weather. Roof openings, windows, and sidewall curtains can enhance ventilation.

Mechanical Ventilation: In large or closed barns, fans and ventilation systems may be needed to maintain air quality and temperature.

Temperature Control: Dairy cows thrive at temperatures between -5°C and 20°C (23°F to 68°F). Shade and cooling mechanisms (like misting or fans) are necessary in hot climates to prevent heat stress.

3. Bedding and Comfort

Comfortable Bedding: Soft, dry bedding materials, like straw, sand, or rubber mats, provide comfort, reduce injuries, and improve lying time. Bedding should be non-abrasive and regularly cleaned or replaced.

Hygiene: Clean, dry bedding reduces the risk of infections, such as mastitis. Frequent bedding maintenance is essential to keep cows comfortable and healthy.

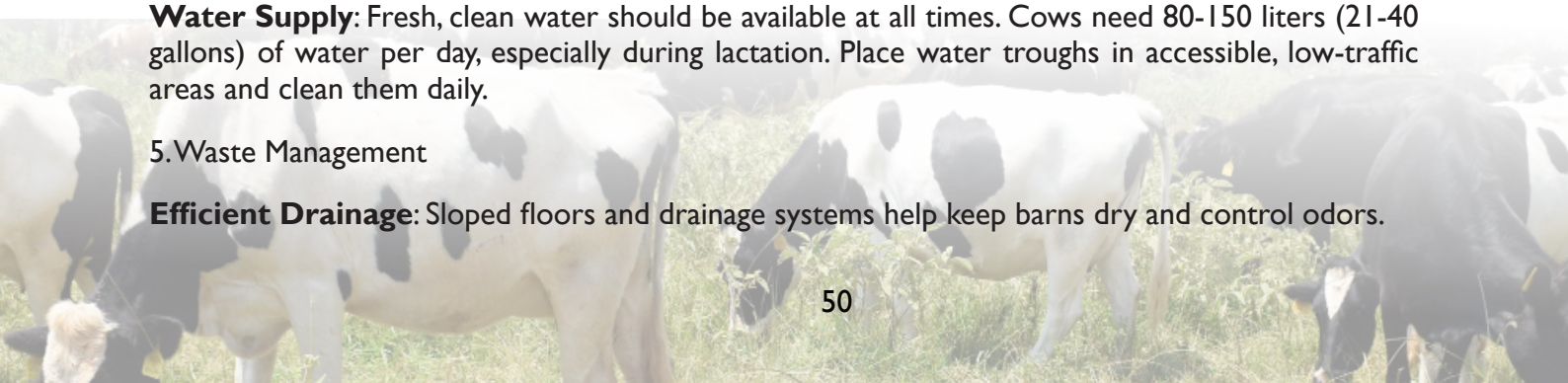
4. Feeding and Water Access

Feed Space: Each cow should have easy access to feed with at least 60-75 cm (2-2.5 feet) of feeding space per cow in group settings to prevent competition.

Water Supply: Fresh, clean water should be available at all times. Cows need 80-150 liters (21-40 gallons) of water per day, especially during lactation. Place water troughs in accessible, low-traffic areas and clean them daily.

5. Waste Management

Efficient Drainage: Sloped floors and drainage systems help keep barns dry and control odors.



Manure Removal: Regular manure removal keeps the area clean, reduces ammonia levels, and minimizes disease. Automated scrapers or manual cleaning routines are used to maintain hygiene.

Holding Pits and Lagoons: Manure should be collected and stored in designated holding pits or lagoons to reduce odor and facilitate proper disposal or repurposing as fertilizer.

6. Lighting

Natural and Artificial Lighting: Dairy cows benefit from about 16-18 hours of light per day. Natural lighting and supplemental artificial lighting help regulate cows' biological rhythms, supporting milk production.

Well-Positioned Lights: Ensure lights are evenly distributed and do not create shadows, which can cause stress or discomfort.

7. Flooring

Non-Slip Flooring: Floors should be textured or grooved to prevent slipping, as cows are prone to injuries on slick surfaces.

Comfortable Materials: Rubber mats or cushioned flooring can reduce leg and hoof injuries, providing better traction and comfort than concrete alone.

8. Milking Area Requirements

Separate Milking Area: A clean, designated milking area or parlor helps maintain milk hygiene and improves efficiency.

Waiting and Holding Pens: Designated pens allow cows to wait comfortably before milking, preventing crowding or stress.

9. Calving Pens

Private Calving Area: A separate area for calving provides comfort and reduces stress for the cow. Clean, well-bedded calving pens help prevent infection and allow for easy monitoring of the cow and calf.

10. Exercise and Outdoor Access

Exercise Area: Access to an exercise yard or pasture benefits cow health, reducing stress and promoting natural behaviors.

Pasture Access: In areas with suitable climates, allowing cows to graze in pastures is beneficial. Pasture access promotes natural foraging, provides fresh air, and supports physical health.

11. Biosecurity and Pest Control

Controlled Entry: Limit access to barns to prevent the introduction of diseases. Use footbaths, disinfection stations, and restricted entry for visitors.

Pest Management: Good waste management, regular cleaning, and proper feed storage help reduce the presence of flies and rodents.

Summary of Benefits of Good Housing

Improved Health and Longevity: Clean, comfortable housing reduces disease, injury, and stress,

contributing to the cow's overall health.

Higher Milk Yield: Comfortable, healthy cows produce more milk.

Reduced Stress: Proper space, ventilation, and lighting help minimize stress, enhancing cow welfare and productivity.

Investing in proper housing is essential for the wellbeing of dairy cows, resulting in healthier animals, better milk quality, and efficient farm management.

7.1 Zero Grazing Layout

A zero-grazing unit layout is designed to maximize the productivity and comfort of dairy cows in a confined space. These units ensure cows have all they need in a central, controlled location without access to grazing areas. Here's an effective layout for a 5-cow zero-grazing unit:

1. Feeding/**Walking and** Watering Area

Location: At the front of the unit.

Design: This area should have a long feed trough (about 0.5–0.6 meters per cow) with easy access to water. **The walking area should be 10ft long.**

Features:

Place the feed trough at a comfortable height for cows to eat without straining.

Automatic water dispensers or troughs are ideal to ensure a constant water supply.

Use non-slip flooring to avoid injuries.

2. Cubicles (Resting Area)

Location: Just behind the feeding area.

Design: Cubicles or stalls are individual resting spaces designed for cows to lie down.

Features:

Provide 5 cubicles, each about 1.2 meters wide and 2.4 meters long.

Use soft, non-abrasive bedding (like sand or rubber mats) to prevent injuries.

Design the cubicles with gentle slope or adequate drainage to keep them dry.

3. Milking Area

Location: Off to one side of the unit to allow easy entry and exit.

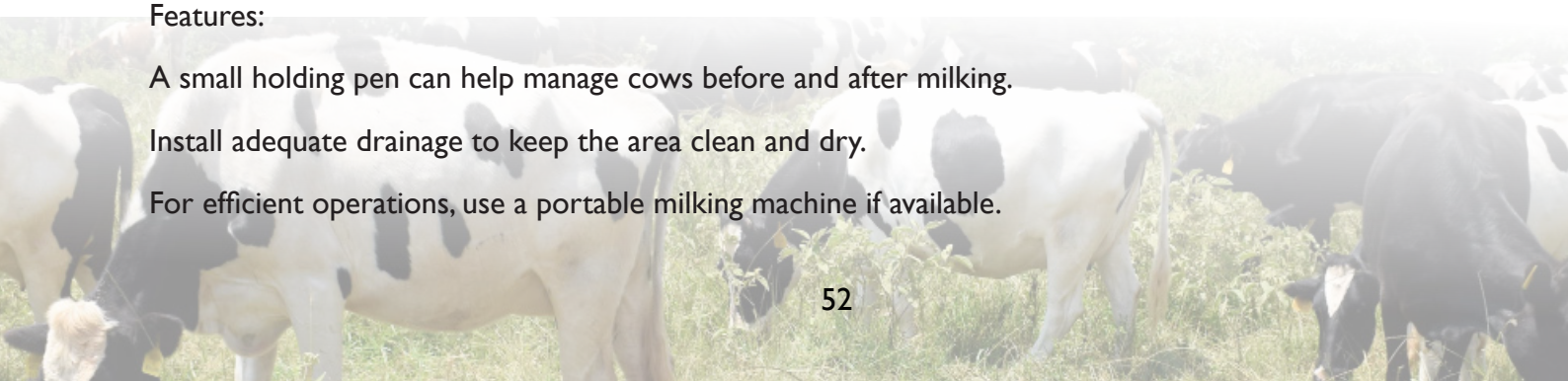
Design: A milking station with easy access to cows and a separate storage area for milking equipment.

Features:

A small holding pen can help manage cows before and after milking.

Install adequate drainage to keep the area clean and dry.

For efficient operations, use a portable milking machine if available.



4. Manure Collection Area

Location: Behind the cubicles, with drainage leading toward a manure pit.

Design: A sloped floor or drainage system can channel manure to the pit.

Features:

Regularly remove manure to maintain cleanliness and reduce odor.

A covered manure pit or tank can prevent flies and odor and allow for composting or bio-gas production.

5. Exercise Yard

Location: Adjacent to the main shelter.

Design: A small open or semi-covered space where cows can move freely.

Features:

Fenced and secure area to allow cows to move, stretch, and exercise.

Ensure non-slip, durable flooring and avoid overcrowding.

Additional Considerations

Ventilation and Lighting: Design the unit with adequate natural ventilation and lighting to promote cow health.

Roofing: A well-insulated roof with rainwater drainage can keep the unit dry and cool.

Pathways: Clear, non-slip pathways within the unit for easy movement between areas.

Biosecurity: Control access to reduce disease risks by limiting entry points and using footbaths.

This layout keeps all essential functions compact and efficient, prioritizing cow comfort, health, and milk productivity.

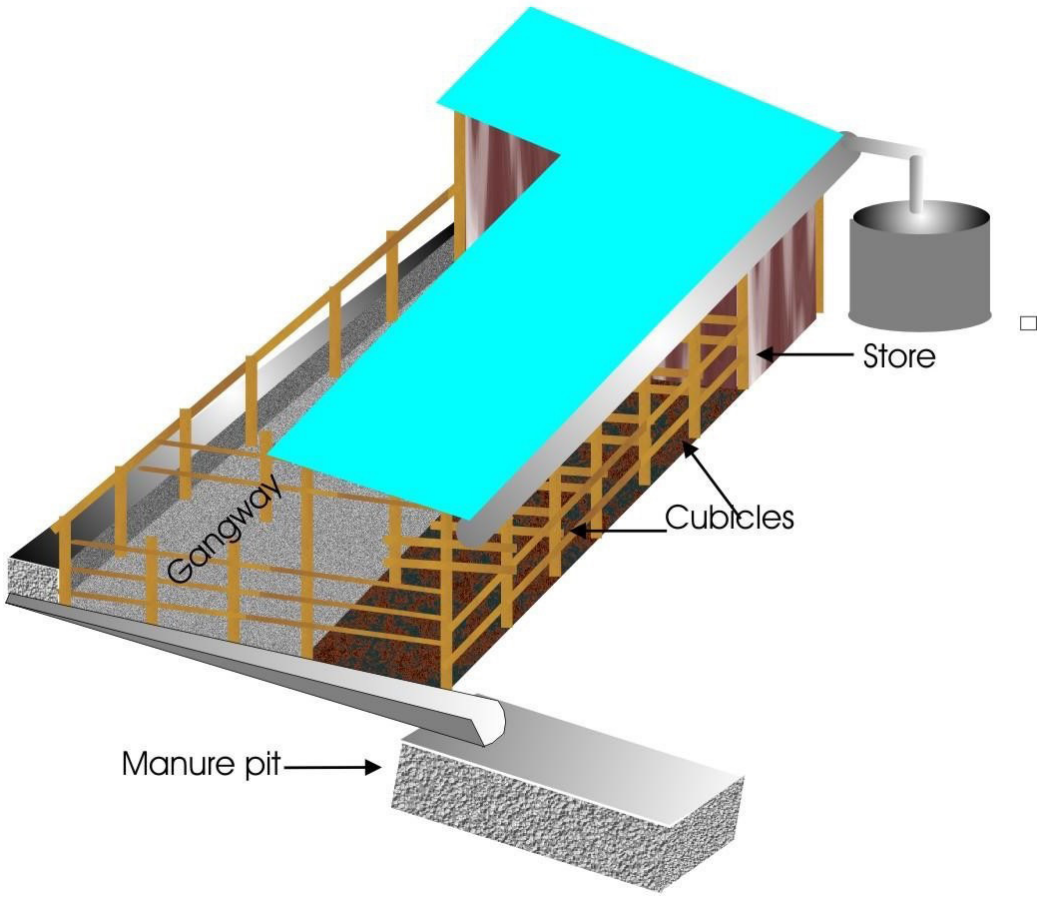
7.1.1 Construction plan

The number of cubicles to construct depends on the number of cows in the herd:

Table 8: A dairy unit construction plan.

Number of cows	Number of cubicles needed
1	2
2	3
3	5
4	6
5	7
6 - 9	9

This plan applies to a herd of 3 cows and two heifers.



Oblique view

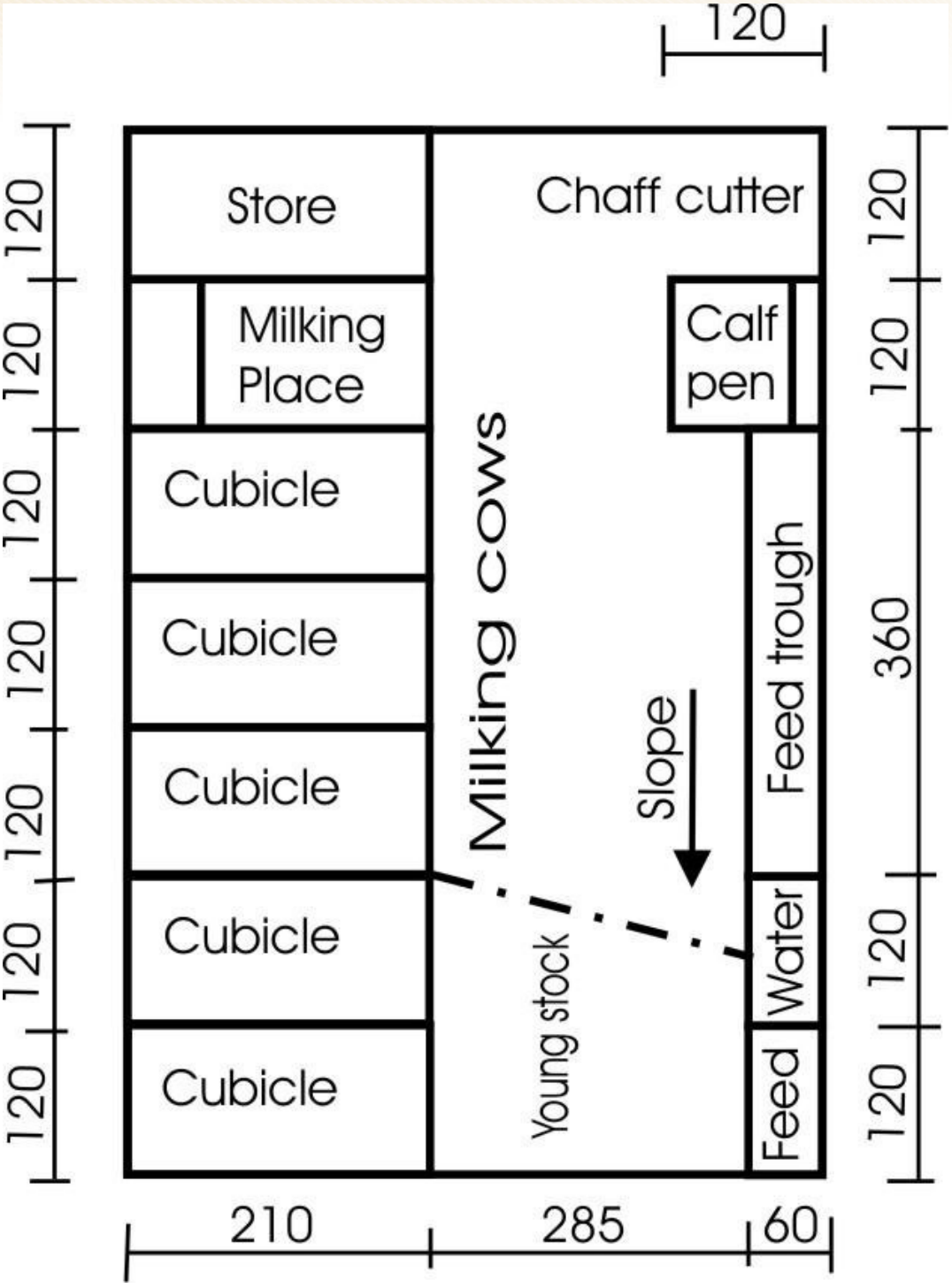


Figure 2: Zero grazing Plan view (Measurements in centimetres)

CHAPTER 8: COMMON DISEASES

8.0 Introduction

Dairy cows are susceptible to several diseases that can impact their health, milk production, and overall welfare. Common diseases in dairy cows include metabolic, infectious, and reproductive disorders. Here's an overview of some of the most prevalent diseases in dairy cows, along with their symptoms, causes, and prevention methods:

8.1 Mastitis

Cause: Bacterial infection of the udder tissue, often due to poor milking hygiene, environmental contaminants, or injury to the udder.

Symptoms:

- Swelling, redness, and warmth of the udder.
- Abnormal milk (clots, blood, or pus).
- Reduced milk production and fever.
- **Prevention**:
- Maintain proper milking hygiene and sanitation.
- Use post-milking teat dips and ensure cows have clean, dry bedding.
- Regularly check for early signs and treat promptly.

8.2 Milk Fever (Hypocalcemia)

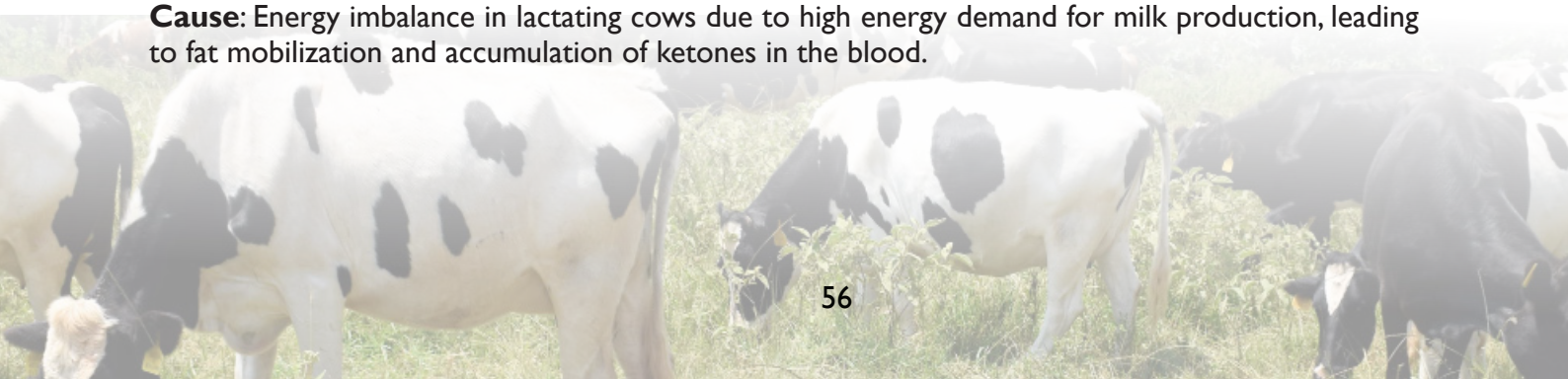
Cause: Low calcium levels in the blood, often affecting cows shortly after calving due to the high calcium demand for milk production.

Symptoms:

- Weakness, inability to stand, muscle tremors, and a "downer cow" posture.
- Cold extremities and a depressed demeanor.
- **Prevention**:
- Provide proper mineral and calcium supplements before and after calving.
- Feed a low-calcium diet before calving to stimulate calcium mobilization.

8.3 Ketosis

Cause: Energy imbalance in lactating cows due to high energy demand for milk production, leading to fat mobilization and accumulation of ketones in the blood.



Symptoms:

Reduced appetite, weight loss, and drop in milk yield.

Sweet or acetone odor on the cow's breath.

Prevention:

- Provide a balanced diet with adequate energy, especially in early lactation.
- Monitor body condition and manage feed intake.

8.4 Displaced Abomasum (DA)

Cause: Displacement of the abomasum (the cow's fourth stomach) to the left or right side, often due to gas buildup and poor dietary management post-calving.

Symptoms:

- Decreased appetite, reduced milk production, and bloating.
- "Ping" sound on percussion of the left or right side of the abdomen.
- **Prevention**:
- Feed a high-fiber diet to encourage normal stomach function.
- Monitor cows closely after calving and provide adequate space for movement.

8.5 Bovine Respiratory Disease (BRD)

Cause:Viral and bacterial infections affecting the respiratory system, often triggered by stress, poor ventilation, and sudden temperature changes.

Symptoms:

- Coughing, nasal discharge, labored breathing, and fever.
- Decreased feed intake and lethargy.

Prevention:

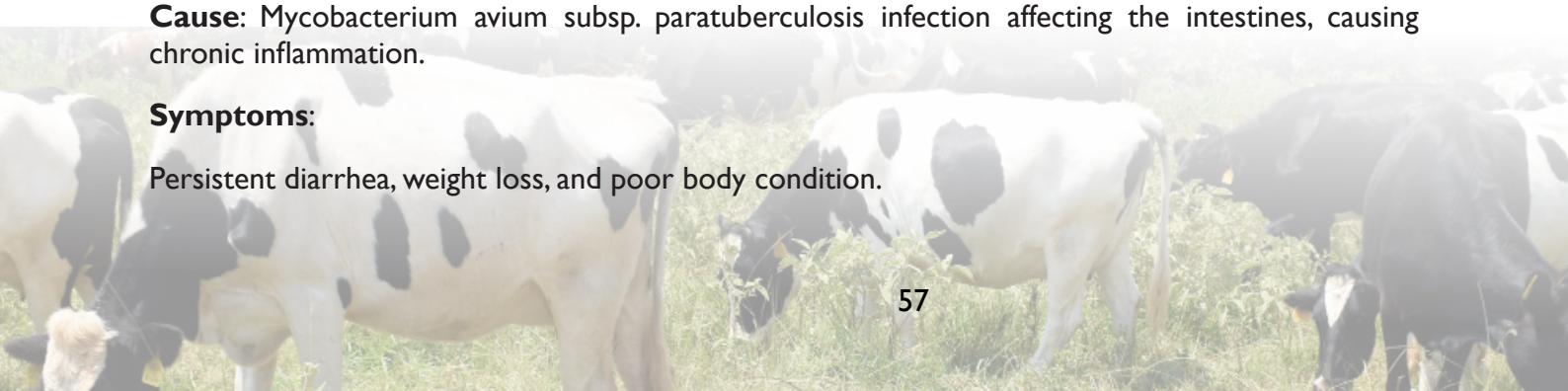
- Ensure good ventilation and minimize stress.
- Vaccinate against common respiratory pathogens.
- Quarantine new or sick animals to prevent disease spread.

8.6 Johne's Disease (Paratuberculosis)

Cause: Mycobacterium avium subsp. paratuberculosis infection affecting the intestines, causing chronic inflammation.

Symptoms:

Persistent diarrhea, weight loss, and poor body condition.



Reduced milk production over time.

Prevention:

- Test and cull infected animals to prevent spread.
- Maintain strict hygiene in calving areas and avoid using manure-contaminated feed and water.

8.7 Foot and Mouth Disease (FMD)

Cause: Highly contagious viral disease affecting cloven-hoofed animals, caused by the foot-and-mouth virus.

Symptoms:

- Fever, blisters on the mouth, tongue, feet, and teats.
- Lameness, drooling, and reluctance to eat.

Prevention:

- Quarantine affected animals and maintain strict biosecurity.
- Vaccinate in regions where the disease is prevalent.
- Restrict movement of animals in and out of the farm.

8.8 Bovine Tuberculosis (TB)

Cause: Mycobacterium bovis infection, affecting the lungs and other organs, and is transmissible to humans.

Symptoms:

Chronic cough, weight loss, reduced milk yield, and general weakness.

Prevention:

- Regular TB testing and culling infected animals.
- Maintain biosecurity and reduce contact with wildlife that may carry the disease.

8.9 Bovine Viral Diarrhea (BVD)

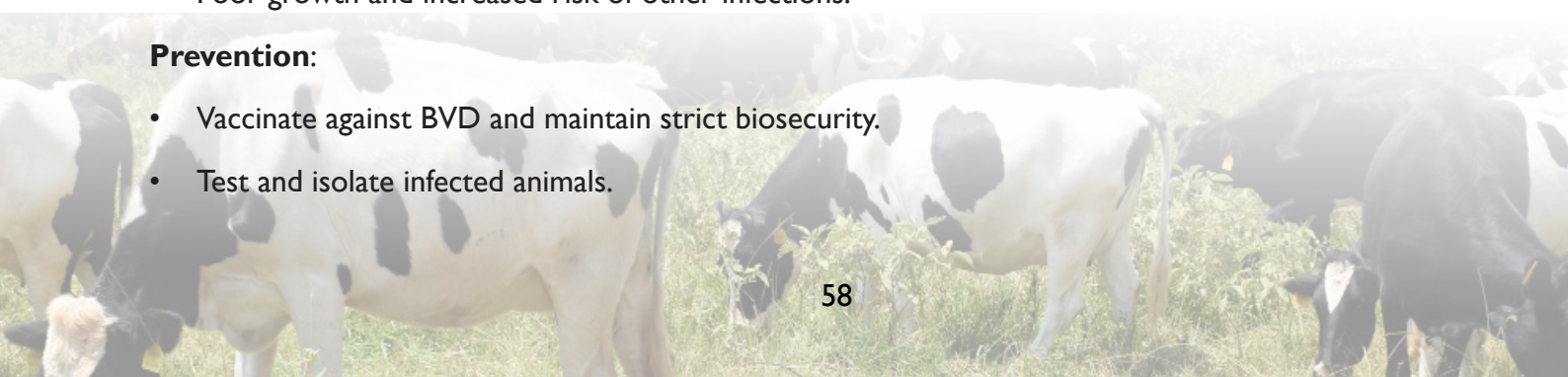
Cause: BVD virus, which can lead to respiratory, gastrointestinal, and reproductive issues.

Symptoms:

- Diarrhea, fever, nasal discharge, and mouth sores.
- Poor growth and increased risk of other infections.

Prevention:

- Vaccinate against BVD and maintain strict biosecurity.
- Test and isolate infected animals.



8.10 Lameness

Cause: Various conditions, including foot rot, sole ulcers, and laminitis, often due to poor nutrition, housing conditions, or injuries.

Symptoms:

Limping, reluctance to move, and swelling in the feet or joints.

Reduced feed intake and milk production.

Prevention:

Regular hoof trimming and proper flooring.

Maintain clean, dry bedding and provide balanced nutrition.

Summary of Prevention and Control

Hygiene and Cleanliness: Regular cleaning of barns, milking equipment, and bedding reduces the risk of infections.

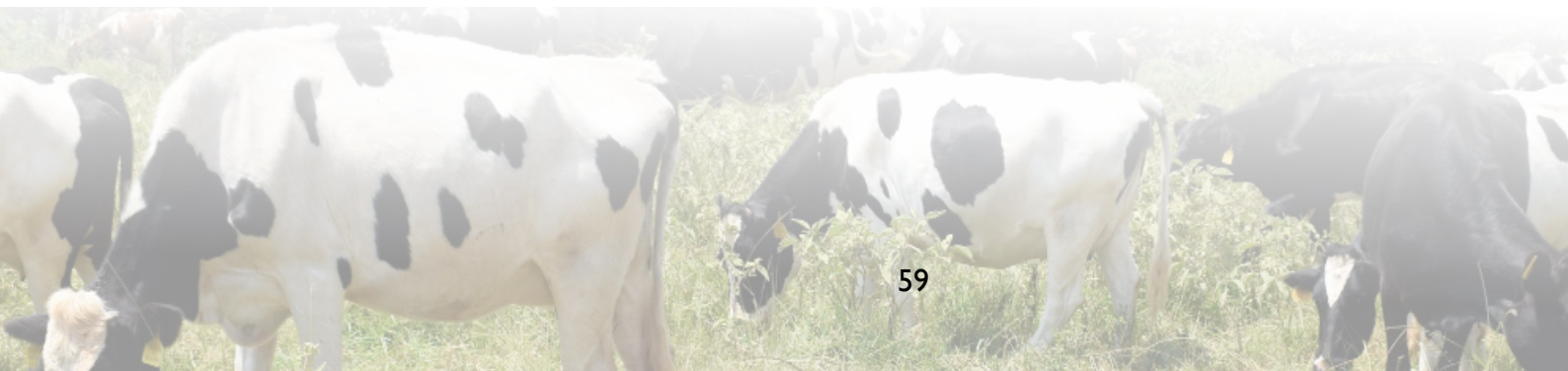
Proper Nutrition: Provide balanced diets tailored to the cow‘s production stage to avoid metabolic diseases.

Vaccination: Regular vaccination programs help protect against common infectious diseases.

Biosecurity: Limit exposure to external pathogens by controlling animal movements, isolating new animals, and maintaining quarantine areas.

Regular Monitoring and Early Treatment: Early detection and prompt treatment of diseases improve recovery and reduce the risk of spread.

Effective disease management through prevention, early detection, and appropriate treatment improves dairy cow health, production, and longevity, ultimately benefiting the entire dairy operation.



CHAPTER 9: AGRIBUSINESS AND MARKETING

9.1 Introduction

Agribusiness and marketing are crucial elements in dairy production, helping farmers and producers optimize profitability, reach consumers, and manage a sustainable dairy enterprise. Successful agribusiness practices and effective marketing strategies ensure efficient production, distribution, and sale of dairy products. Here's a guide to agribusiness and marketing in dairy production:

1. Understanding Agribusiness in Dairy Production

Supply Chain Management: Agribusiness in dairy involves managing the entire supply chain—from inputs like feed, equipment, and genetics to the processing and distribution of dairy products. Efficient supply chain management reduces costs and improves product quality.

Value Addition: Adding value to raw milk by processing it into products such as cheese, yogurt, butter, or packaged milk boosts revenue. Value-added products often have a longer shelf life and higher profit margins than raw milk.

Economies of Scale: Expanding production to benefit from economies of scale can reduce per-unit costs, improve efficiency, and increase profitability.

Sustainability Practices: Consumers increasingly value environmentally sustainable practices. Sustainable dairy agribusiness practices, like waste recycling, water conservation, and minimizing greenhouse gas emissions, improve brand image and appeal to eco-conscious markets.

Technology and Automation: Investing in technology for automation (e.g., robotic milking machines, feed management software) enhances production efficiency, reduces labor costs, and ensures consistent product quality.

2. Marketing Strategies for Dairy Products

Product Differentiation: Differentiating dairy products based on quality, organic certification, grass-fed or pasture-raised claims, and health benefits (like probiotics in yogurt) helps attract niche markets.

Branding and Packaging: A strong brand identity with appealing packaging and labels makes products stand out on store shelves and builds customer loyalty. Clear labeling, including nutritional information and product origin, builds trust with consumers.

Digital and Social Media Marketing: Utilizing social media platforms to share content about the dairy farm, animal welfare, and sustainability efforts helps engage consumers and build brand loyalty. Many dairy brands use social media for storytelling, connecting directly with consumers, and showcasing transparency in production.

Direct-to-Consumer Sales: Many consumers prefer purchasing directly from farms or online. By creating an online presence and offering delivery services, farms can reach local customers directly, increasing profits and building closer customer relationships.

Promotions and Sampling: Offering free samples in stores or at events helps introduce consumers to new dairy products. Coupons, discounts, or bundling products can also encourage purchases and increase brand recognition.

3. Distribution Channels in Dairy Marketing

Retail and Grocery Stores: Supermarkets and grocery stores are the primary sales channels for dairy products. Securing shelf space and negotiating favorable terms with retailers are key to reaching a large audience.

Wholesale and Bulk Sales: Selling dairy products in bulk to restaurants, cafes, hotels, and schools provides steady income streams and larger sales volumes. Bulk sales are especially common for milk, cream, and cheese.

Farmers' Markets: Selling directly at farmers' markets allows dairy producers to connect with consumers, build brand loyalty, and receive immediate feedback. It also enables premium pricing, as consumers value direct, fresh purchases.

Online Platforms and Subscription Services: An increasing number of consumers purchase dairy products online through farm websites or e-commerce platforms. Subscription services for regular delivery of fresh milk, cheese, or yogurt appeal to health-conscious and convenience-oriented customers.

Export Markets: Expanding into export markets can provide significant growth opportunities, especially for high-value dairy products like specialty cheeses and powdered milk. Exporting, however, requires navigating regulations, certifications, and quality standards specific to the target country.

4. Pricing Strategies in Dairy Marketing

Cost-Plus Pricing: Setting prices based on production costs plus a profit margin ensures profitability while keeping products competitive.

Premium Pricing: For organic, specialty, or artisan dairy products, premium pricing strategies allow producers to charge more based on product uniqueness, quality, or health benefits.

Competitive Pricing: Analyzing competitors' prices and setting a similar price range can help dairy producers stay competitive in the market.

Seasonal Pricing: Adjusting prices based on demand fluctuations (e.g., holiday seasons for butter and cheese) or milk supply variations can help balance inventory and maintain profitability.

Volume Discounts: Offering lower prices for bulk purchases attracts wholesale buyers and institutions.

5. Product Development and Innovation

New Product Development: Introducing innovative products (e.g., lactose-free milk, flavored milk, or probiotic yogurt) caters to changing consumer preferences, dietary restrictions, and health trends.

Sustainable Packaging Innovations: Consumers increasingly prefer eco-friendly packaging. Transitioning to biodegradable or recyclable containers can differentiate a dairy brand and meet consumer demand for sustainable options.

Health and Wellness Products: Developing products that appeal to health-conscious consumers, like low-fat, high-protein, or fortified dairy items, can open up new market segments.

6. Quality Assurance and Food Safety

Quality Control: Consistent product quality builds brand trust. Dairy agribusinesses implement strict quality control measures at every production stage, from milking hygiene to final packaging.

Food Safety Certifications: Certifications, such as HACCP (Hazard Analysis and Critical Control Points) and organic certification, help assure consumers of the product's safety and quality.

Traceability and Transparency: Tracking the entire production process and clearly labeling product origins assures consumers of food safety and enhances brand credibility.

7. Sustainability and Animal Welfare in Marketing

Eco-Friendly Practices: Highlighting sustainable practices, such as waste recycling, water conservation, and using renewable energy, appeals to environmentally conscious consumers.

Animal Welfare Standards: Marketing based on animal welfare standards, such as pasture-raised or humanely treated cows, can be highly attractive to ethical consumers. Sharing farm practices on animal care through videos or social media can strengthen consumer trust.

8. Challenges in Dairy Agribusiness and Marketing

Market Volatility: Dairy prices fluctuate due to supply-demand imbalances, input costs, and global market conditions. Price protection measures, like hedging or supply contracts, can help mitigate this risk.

Rising Production Costs: Costs for feed, labor, energy, and health care for animals are constantly increasing, affecting profitability. Efficiency improvements and government subsidies can help alleviate these pressures.

Regulatory Compliance: Meeting local, national, and international regulations for food safety, labeling, and animal welfare is critical. Non-compliance can lead to penalties or restrictions, impacting market access.

Consumer Preferences: Adapting to changing consumer trends, such as preferences for plant-based alternatives or low-sugar products, requires market research and flexibility.

9. The Importance of Branding and Customer Relationships

Building Brand Identity: A strong brand identity conveys quality, sustainability, and reliability, helping dairy products stand out in a competitive market.

Customer Engagement: Interacting with customers through social media, newsletters, and events can build loyalty and generate valuable feedback.

Transparency and Trust: Consumers increasingly value transparency. Sharing information on sourcing, production processes, and animal care fosters trust and can lead to long-term customer loyalty.

Table 9: A dairy gross margin calculation guide.

GROSS MARGIN FOR TWO DAIRY COWS						
S/NO	END OF YEAR ACTIVITY	UNIT	NO.	Price /unit	Yr0	Yr1
1	**GROSS INFLOWS**					
2	Milk Prod. Per day @15lts for 300 days	Lts	9000	60	540,000	540,000
3	Heifers	No.	2	15000	-	30,000
4	Manures	Tons	20	2000	40,000	40,000
5	Cull cows	No.	2	20000	-	-
6	**TOTAL INFLOWS**				**580,000**	**610,000**
7	**GROSS OUTFLOWS**					
8	Zero grazing Unit	No.	1	100000	100000	0
9	**Farm equipments**					
10	Foot pump	No.	1	15000	15000	0
11	Chaff cutter	No.	1	45000	45000	0
12	Milk pail 10lts	No.	2	5000	5000	0
13	Panga/jembe/rake	No.	1	3000	3000	0
14	Dairy cows incalf	No.	2	70000	140000	0
15	**Napier establishment**					
16	Ploughing (1&2)	Acre	1	3000	3000	0
17	Planting materials	Acre	1	5000	5000	0
18	DAP	No.	2	2500	5000	0
19	Planting napier	MD	12	300	3600	0
20	**Napier maitenance**					
21	CAN-50KGS/yr/acre	No.	1	2000	2000	2000
22	Manures	Tons	20	2000	40000	40000
23	Weeding	MD	12	300	3600	3600
24	**Annual Costs-Labour**	MD	360	200	72000	72000
25	Milking	0	0	0	0	0
26	Feeding	0	0	0	0	0
27	Spraying	0	0	0	0	0
28	Top dressing	0	0	0	0	0
29	Dairy meal-70kg	Bags	32	2500	80000	80000
30	Mineral salt	kg	73	100	7300	7300
31	Acaricide	Months	12	100	1200	1200
32	Dewormers	Months	12	100	1200	1200
33	Curative drugs	Months	12	200	2400	2400
34	A.I	No.	1	1000	1000	1000
35	Milk salve	cow	2	200	400	400
36	Mastrite-100gms	Bottle	2	500	1000	1000
37	Bacterigents	Lts	12	200	2400	2400
38	**CALF REARING**					
39	Milk Fed -2 calves	Lts	150	30	4500	45000
40	Calf Pellets	Bags	2	1500	3000	3000
41	Transport of inputs		12	100	1200	1200
42		SUB-TOTAL			547800	263700
43	**GROSS ANNUAL FLOW**				**32,200**	**346,300**

N/B: The costing figures may change depending on the prevailing market prices.

Successful agribusiness and marketing in dairy production require efficient production practices,

value addition, and an understanding of consumer needs. With effective supply chain management, strategic marketing, and a focus on quality, dairy producers can enhance profitability and establish a strong presence in both local and international markets.

9.2 Busineness opportunities in dairy cow production

Dairy cow production offers a range of business opportunities due to the global demand for dairy products such as milk, cheese, butter, and yogurt. Depending on your resources, expertise, and market conditions, here are several business opportunities in dairy cow production:

1. Dairy Farming (Milk Production)

Core Business: The most common form of dairy cow production, where cows are raised to produce milk. This business can be scaled depending on the farm size and technology used.

Opportunities:

Supply Chain: Establish a local supply chain to distribute fresh milk to markets, grocery stores, and processing plants.

Organic Milk Production: Organic milk production is in high demand due to health-conscious consumers.

2. Milk Processing

Core Business: Turning raw milk into various processed dairy products such as cheese, yogurt, butter, ice cream, or milk powder.

Opportunities:

Value Addition: By creating specialized dairy products, you can tap into premium markets.

Packaging: Invest in packaging technologies to provide long shelf-life products.

Brand Development: Build a strong brand to stand out in the competitive dairy market.

3. Artificial Insemination (AI) and Breeding Services

Core Business: Providing genetic services to dairy farmers by offering AI, semen collection, and genetic consulting.

Opportunities:

Specialized Breeding Programs: Offer breeding services that focus on increasing milk production, disease resistance, or cow longevity.

Genetic Material Sales: Sell high-quality semen from top-performing dairy breeds.

4. Dairy Cow Feed Production

Core Business: Producing and selling high-quality feed for dairy cows. This is essential to ensure the cows' health and milk production.

Opportunities:

Feed Formulation: Create custom feed blends based on local agricultural by-products or specialized nutritional needs for high-performance cows.

Sustainable Feed: Focus on producing environmentally friendly or organic feeds.

Online Sales: Offer feed directly to farms through e-commerce platforms.

5. Cow Manure Management and Fertilizer Production

- **Core Business**: Using cow manure as a raw material to produce organic fertilizers or biogas.
- **Opportunities**:
- **Composting**: Process manure into compost and sell it to local farms or gardens.
- **Biogas Production**: Invest in biogas plants to convert manure into energy or bio-fertilizer.
- **Sustainability**: Market your manure-derived products as eco-friendly solutions for sustainable agriculture.

6. Dairy Cow Health and Veterinary Services

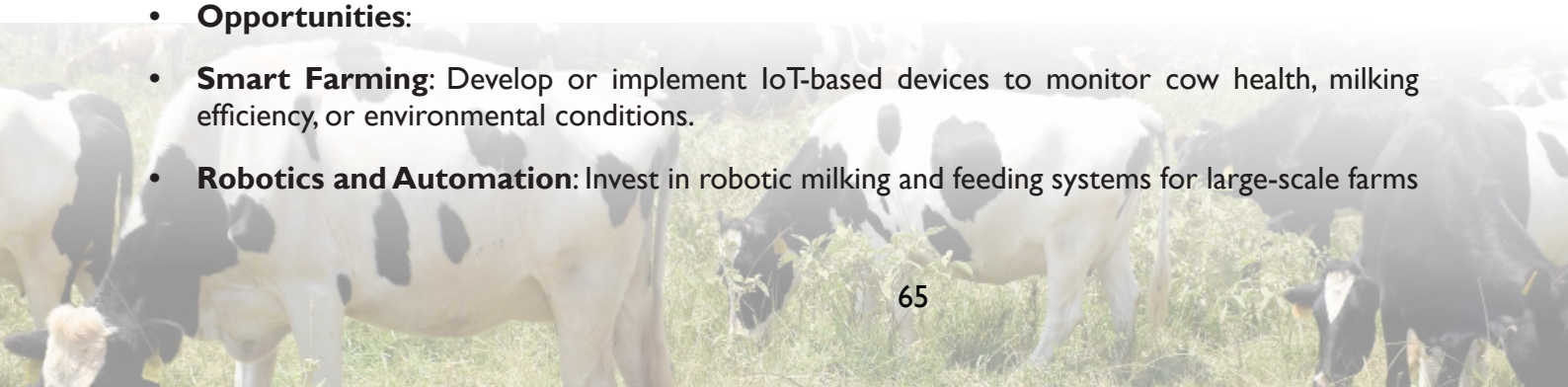
- **Core Business**: Providing healthcare services specifically for dairy cows, including vaccination, disease management, and overall health consultation.
- **Opportunities**:
- **Preventative Healthcare**: Offer routine check-ups, vaccinations, and parasite management.
- **Mobile Veterinary Services**: Start a mobile veterinary service to cater to remote dairy farms.
- **Nutritional Consulting**: Advise dairy farmers on optimizing their cows‘ diet for better milk yields.

7. Dairy Cow Housing and Equipment

- **Core Business**: Providing dairy farms with housing solutions, milking equipment, and other related technologies.
- **Opportunities**:
- **Automated Milking Systems**: Invest in and provide automated milking systems that reduce labor costs and improve efficiency.
- **Cow Comfort**: Develop or sell products that improve cow comfort, like ventilation, cooling systems, or improved bedding materials.
- **Sustainable Buildings**: Build eco-friendly or energy-efficient dairy cow housing.

8. Dairy Cow Technology (Tech Innovations)

- **Core Business**: Using technology to improve productivity and efficiency in dairy farming operations.
- **Opportunities**:
- **Smart Farming**: Develop or implement IoT-based devices to monitor cow health, milking efficiency, or environmental conditions.
- **Robotics and Automation**: Invest in robotic milking and feeding systems for large-scale farms



- **Data Analytics**: Offer data-driven solutions to monitor herd performance and optimize milk production.

9. Dairy Cow Tourism or Agritourism

- **Core Business**: Using dairy farming as a tourist attraction by offering farm tours, farm-to-table experiences, or milk production experiences.
- **Opportunities**:
- **Farm Tours and Workshops**: Educate the public about the dairy industry, sustainable farming, or cheese-making.
- **Farm Stays**: Create accommodations for tourists who want to experience life on a working dairy farm.
- **Local Dairy Products**: Offer locally made dairy products to tourists as part of the experience.

10. Sustainable and Ethical Dairy Farming

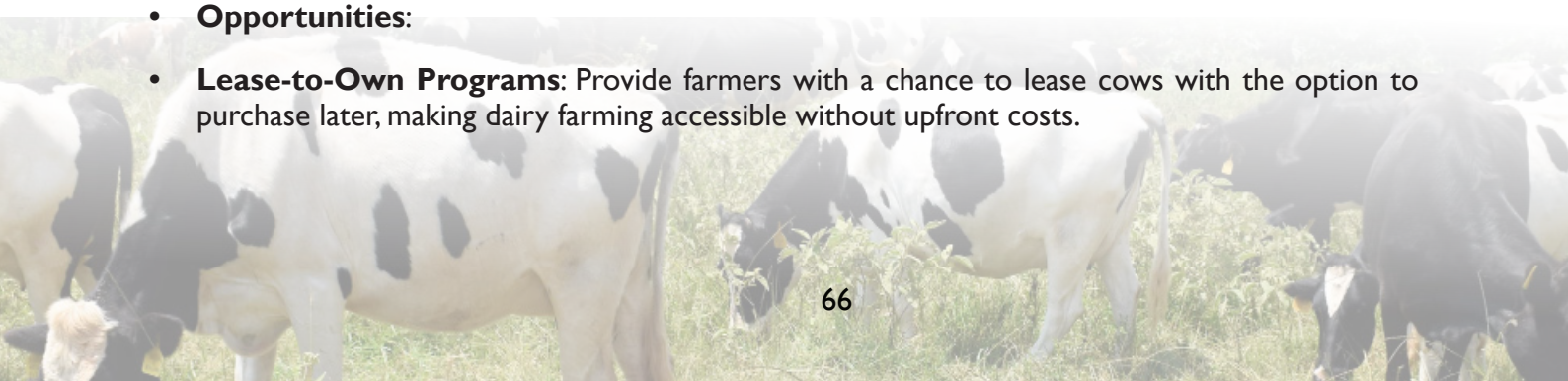
- **Core Business**: Focus on creating a dairy farm that follows ethical and sustainable practices, appealing to consumers who prioritize animal welfare and environmental impact.
- **Opportunities**:
- **Animal Welfare Certification**: Obtain certifications such as Certified Humane or Animal Welfare Approved to attract ethical consumers.
- **Sustainable Practices**: Implement eco-friendly practices such as rotational grazing, renewable energy sources, and water conservation.
- **Marketing**: Leverage ethical branding to target niche markets of conscious consumers.

11. Import/Export of Dairy Products

- **Core Business**: Exporting or importing dairy products from regions where demand is high or prices are favorable.
- **Opportunities**:
- **International Markets**: Identify under-supplied international markets for dairy products and build a robust export supply chain.
- **Product Diversification**: Diversify your dairy exports by including specialized products like lactose-free milk, plant-based alternatives, or ethnic dairy products.

12. Dairy Cow Leasing

- **Core Business**: Offering dairy cows on a lease or rental basis to other farmers or entrepreneurs.
- **Opportunities**:
- **Lease-to-Own Programs**: Provide farmers with a chance to lease cows with the option to purchase later, making dairy farming accessible without upfront costs.



- **Short-Term Rentals**: Offer dairy cows to farms that need temporary support during peak production seasons.

Each of these opportunities requires careful planning, market research, and investment in infrastructure and technology. Exploring these niches could help you identify the right path based on your location, resources, and expertise.

CHAPTER 10: DAIRY FARM RECORDS

10.0 Introduction

In dairy production, keeping accurate and organized records is essential for managing the herd, monitoring productivity, ensuring animal health, and maintaining profitability. Good records allow dairy farmers to make data-driven decisions that can improve farm efficiency and compliance with industry standards. Below are key types of records commonly kept in dairy production and their importance:

10.1 Animal Health Records

Vaccination and Treatment Records: Track vaccinations, treatments for illnesses, deworming schedules, and any antibiotics or medications given. This helps monitor cow health and is crucial for food safety compliance.

Veterinary Visits and Health Checks: Records of veterinary check-ups, diagnoses, and prescribed treatments provide a comprehensive health history for each animal.

Disease and Mortality Records: Tracking occurrences of diseases, injuries, or mortality rates helps identify patterns that may need addressing in herd management or housing conditions.

10.2 Milk Production Records

Daily and Monthly Milk Yields: Recording daily milk production for each cow helps monitor individual and overall herd productivity.

Milk Quality Data: Records of milk fat, protein content, and somatic cell counts are critical for tracking milk quality and detecting potential health issues, such as mastitis.

Peak Milk Production: Recording peak milk production levels allows for the evaluation of a cow's productivity over her lactation cycle and helps in future breeding decisions.

10.3 Breeding and Reproduction Records

Estrus (Heat) Detection Records: Track dates and behaviors associated with estrus to predict optimal breeding times.

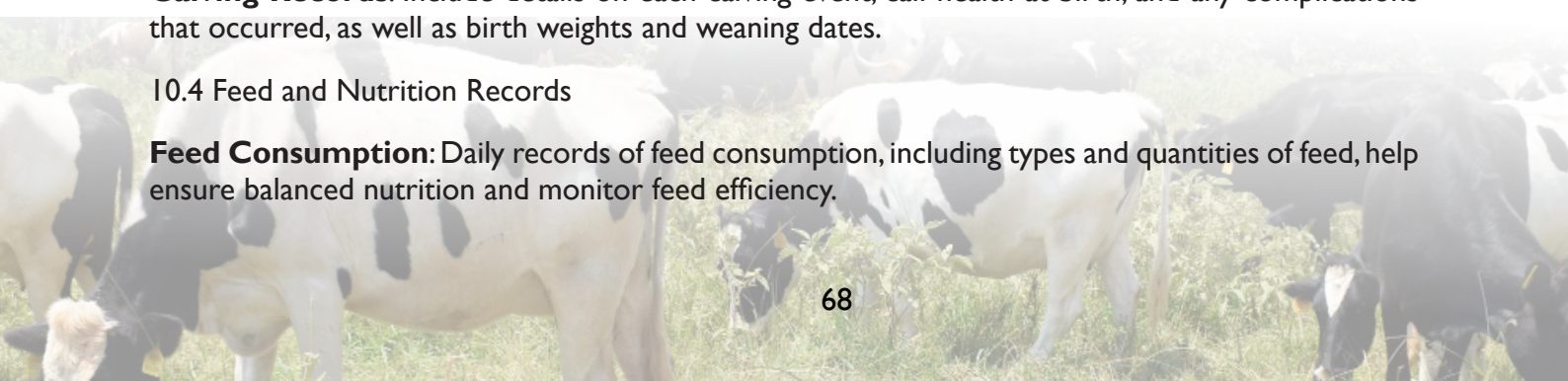
Artificial Insemination (AI) and Breeding Dates: Keep records of breeding dates, AI details, and bull or semen ID used for each cow. This helps track genetic lineage and manage reproductive schedules.

Pregnancy Checks and Calving Dates: Recording pregnancy checks, expected calving dates, and actual birth dates aids in planning for calving and lactation cycles.

Calving Records: Include details on each calving event, calf health at birth, and any complications that occurred, as well as birth weights and weaning dates.

10.4 Feed and Nutrition Records

Feed Consumption: Daily records of feed consumption, including types and quantities of feed, help ensure balanced nutrition and monitor feed efficiency.



Feed Costs: Track the cost of different feed components to manage expenses and identify cost-effective nutrition strategies.

Nutritional Composition of Feed: Record nutrient analysis (e.g., crude protein, energy content) of feed to ensure cows meet their dietary requirements.

Body Condition Scores: Keeping track of body condition scores (BCS) at regular intervals helps assess if the feeding program is appropriate for each cow's stage of lactation or pregnancy.

10.5 Financial Records

Income from Milk Sales: Record the volume and price of milk sold to track revenue trends and overall profitability.

Feed, Labor, and Operating Costs: Documenting all operating expenses, including feed, labor, utilities, equipment, and maintenance, provides an overview of the farm's profitability.

Capital Investments and Asset Records: Records of investments in equipment, infrastructure, and herd acquisitions (like purchasing new cows) are essential for tax purposes and calculating farm value.

Debt and Loan Records: Keeping track of any loans, interest rates, and repayment schedules helps manage cash flow and financial planning.

10.6 Labor and Workforce Records

Employee Schedules and Attendance: Tracking work schedules and attendance helps manage labor costs and productivity.

Training and Certifications: Documenting employee training (such as milking procedures, animal handling, or health certifications) ensures a skilled workforce and helps with compliance.

Labor Costs and Wages: Records of wages, bonuses, and other payments are necessary for budgeting and payroll management.

10.7 Environmental and Waste Management Records

Manure Management: Record manure production, storage, and disposal practices to ensure compliance with environmental regulations and to manage nutrient recycling.

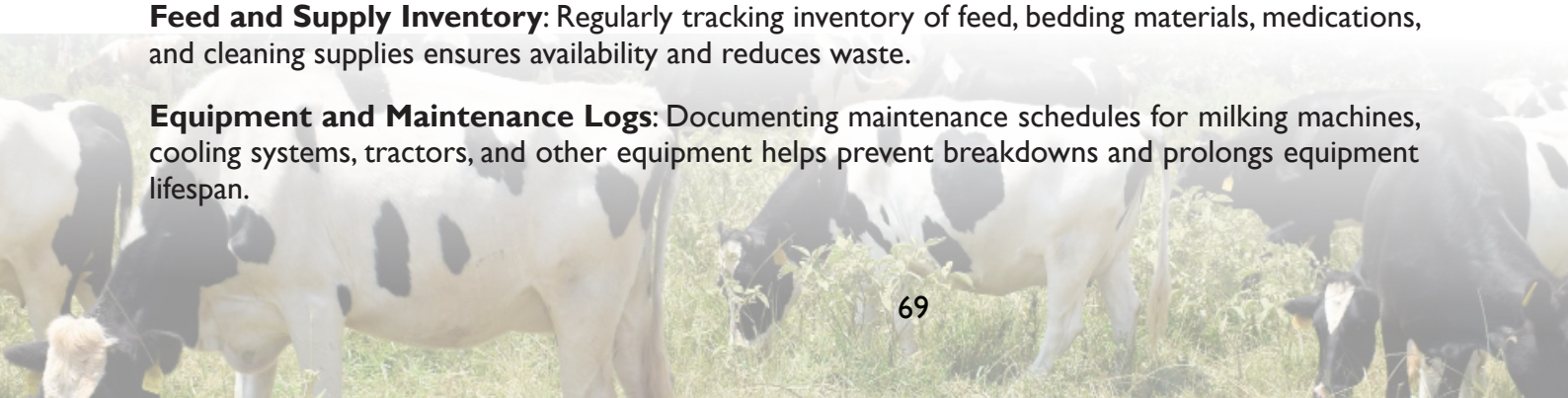
Water Usage and Quality: Monitoring water consumption and quality helps in managing resources efficiently and ensures that water used for cows and cleaning meets quality standards.

Energy Usage: Tracking electricity, fuel, and other energy sources can help reduce costs and improve the farm's environmental sustainability.

10.8 Inventory and Supplies Records

Feed and Supply Inventory: Regularly tracking inventory of feed, bedding materials, medications, and cleaning supplies ensures availability and reduces waste.

Equipment and Maintenance Logs: Documenting maintenance schedules for milking machines, cooling systems, tractors, and other equipment helps prevent breakdowns and prolongs equipment lifespan.



10.9 Genetic and Performance Records

Genetic Lineage: Keeping track of each cow's sire and dam, along with genetic traits, helps inform breeding decisions for desired characteristics like high milk yield or disease resistance.

Performance Testing: Records of performance tests for traits such as milk yield, growth rate, and reproductive efficiency aid in identifying high-performing animals for breeding purposes.

10.10 Regulatory and Compliance Records

Food Safety and Traceability: Documentation related to food safety standards, including milk quality tests, animal treatment records, and traceability, is essential for regulatory compliance.

Environmental Permits and Inspections: Maintaining records of permits, inspections, and compliance with environmental regulations helps avoid legal issues and potential fines.

10.11 Benefits of Keeping Detailed Records in Dairy Production

Enhanced Productivity: Identifying trends in milk yield, feed efficiency, and herd health helps optimize practices for improved production.

Better Health Management: Early detection of health issues, based on historical health and milk quality data, allows for timely intervention and reduces treatment costs.

Improved Financial Management: Accurate financial records help manage costs, increase profitability, and make informed decisions on pricing and investments.

Informed Breeding Decisions: Reproductive and genetic records aid in selecting superior animals for breeding, resulting in a healthier, higher-yielding herd over time.

Regulatory Compliance: Detailed records ensure compliance with legal and industry standards, helping avoid penalties and maintain a good reputation with regulatory bodies.

Efficient Resource Use: Tracking feed, water, and energy usage leads to cost savings and supports environmental sustainability.

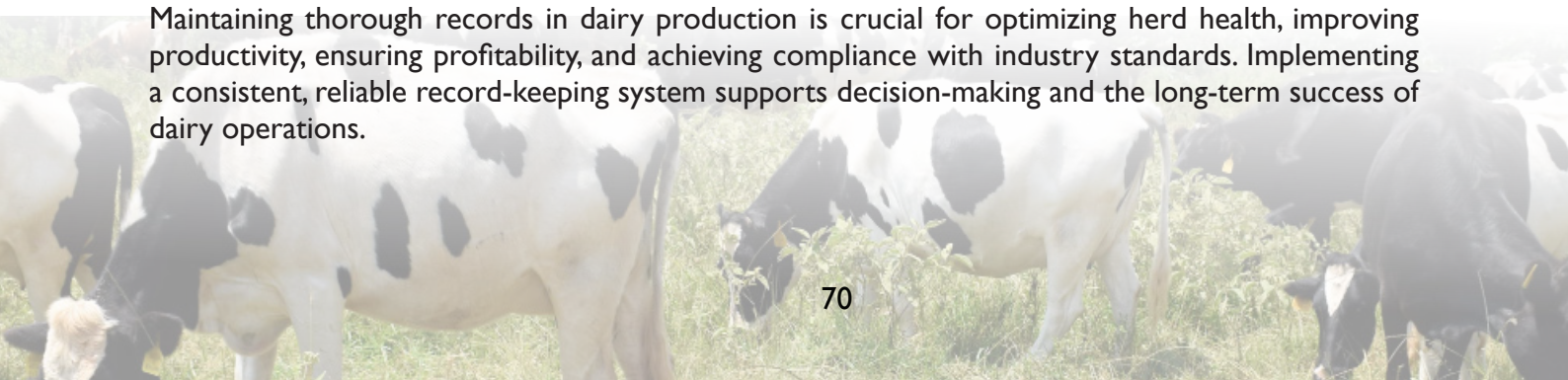
10.12 Record-Keeping Systems and Tools

Digital Record-Keeping Software: Specialized dairy management software, such as DairyComp, CowManager, and BoviSync, can automate record collection, making data accessible and easier to analyze.

Manual Records: Traditional paper records are still used on smaller farms but may require more labor for organization and are less efficient than digital systems.

Mobile Apps and Cloud-Based Solutions: Mobile apps allow farm managers to enter data on-the-go, making record-keeping more convenient and reducing the risk of errors from delayed data entry.

Maintaining thorough records in dairy production is crucial for optimizing herd health, improving productivity, ensuring profitability, and achieving compliance with industry standards. Implementing a consistent, reliable record-keeping system supports decision-making and the long-term success of dairy operations.



CHAPTER 11: GENDER EQUALITY, HUMAN RIGHTS AND SOCIAL INCLUSION

11.0 Background

Studies conducted during implementation of the various value chains identified gender and human rights related challenges to participation. Women reported that cultural issues affected their rights to own land preventing their involvement in value chain activities as they could not make decisions on what to plant since all agricultural activities are dependent on land as a factor of production.

Gender roles ,triple roles for women -Reproductive. Productive and community management for women while Men's role is productive, and community politics were also sited as a hindrance to women's involvement in value chains .

Cultural practices like wife cleansing and inheritance, especially in some counties, denied widows an opportunity to participate in the value chain activities. Decision making at the household level relating to value chain selection were mostly done by men, though in some instances, women also participated in the process. But where men had migrated to towns, women were the sole decision makers on selection of value chain(s). in some counties, men dominated in decision making concerning value addition, grading, marketing, savings, access to agricultural and marketing information, as well as access to credit and training. Women and youth could not initiate any agriculture-based Income Generating Activities (IGAs) without permission from the husbands/fathers or the elderly men in the family due to cultural beliefs and patriarchy.

High illiteracy levels and low skills especially among women left them vulnerable in terms of technical matters in the value chain activities. Several farmer groups believed both English and Kiswahili languages be adopted during training, Trainers were said to use a lot of English when training and it confused the farmers making language and methodologies used a barrier.

Lack of markets: Exploitation by intermediaries affected the prices of most of the value chain produce. It was suggested that market linkages with potential external buyers be established and strengthened.

Gender and extension services - Extension services were provided to the farmers through group training and through telephone calls by private extension officers and county government extension officers. The youth indicated that the extension training courses were done early during the day when they had reported for other activities such as attending other fishponds, harvesting excluding them from the services. Women also complained that the time at which the extension trainings are done did not favour them as they are attending to domestic chores or farm activities denying them the opportunity to gain experience.

Youth attributed their inadequate participation in value chain production activities to lack of land ownership since the parents (fathers) were not willing to give them land on a permanent basis. As a result, there was serious conflict between the young men and their fathers in counties in some

Widowhood – Women in all the sampled counties were targeted because of their status as widows, and the fight for family land and other capital assets always starts immediately after the husband died. Being a widow left them vulnerable to other families or even community members who want their land and other assets. In some cases, family members secretly alter particulars of ownership documents such as title deeds to the disadvantage of widowed women.

People with disabilities often experience discrimination in their everyday life. Discrimination describes a situation where an individual is disadvantaged in some way because of a 'protected characteristic.' Discrimination takes place in different forms. It can be direct or indirect, manifest in the form of harassment, or there can be direct instructions to discriminate. Direct discrimination is based on negative attitudes, prejudice, and/or on discriminatory legislation. Indirect discrimination, for example, can be caused by physical barriers, such as stairs as the only means to get to vital locations, or using media. For example, people who are visually impaired or have difficulties hearing cannot use media without assistance.

Most of the respondents requested special training on gender mainstreaming and gender-based violence and human rights, hence this manual. The findings came from the report below and gender analysis of selected value chains conducted by the Gender Youth and Social Inclusion Advisor, MESPT in August 2024 (G.V. Masinde and C.K. Wambu, PhD November, 2021Final draft report *A Gender Equality and Human Rights Approach for The Green Employment in Agriculture Programme (GEAP), MESPT)*

11.1.1 Definition and key concepts

Sex: It identifies the biological differences between men and women. Kenya recognized and counted intersex persons during the census in 2019.

Intersex: Intersexuality is an overarching term that refers to human bodies that fall outside the strict male and female binary. The term refers to the many variations—often present at birth—that can affect a person's reproductive or sexual anatomy, which may involve genitalia, hormones, reproductive organs, and chromosomes.

For example, these variations might include being born with "female" anatomy on the outside, such as a vaginal opening, but having "male" sexual organs on the inside.- Intersex: What It Means, How It's Identified accessed on 14/11/2024

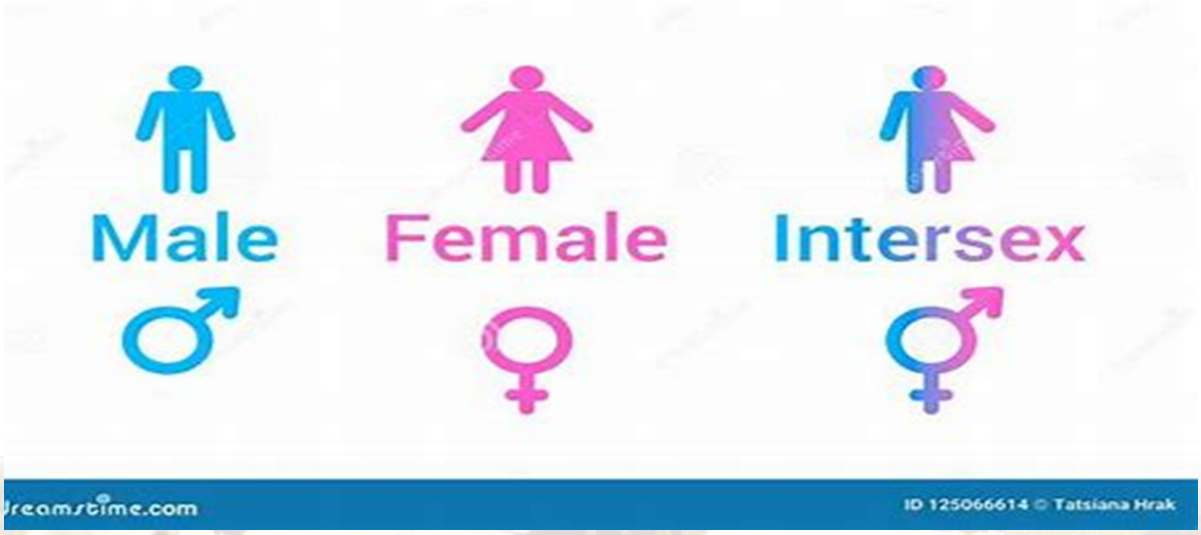


Figure 1:Kenya recognizes three genders Two genders? No, we should recognize the three in Kenya | Nation

Gender : Refers to the socio-cultural differences and relations between men and women that are learned, changeable over time, and have wide variations both within and between societies and cultures. The concept of gender also includes expectations held about the characteristics, attitudes and behavior of women and men (femininity and masculinity).

Gender equality: This is a human right that is enshrined in several declarations and conventions, including the legally binding Convention on the Elimination of All Forms of Discrimination against Women (CEDAW).

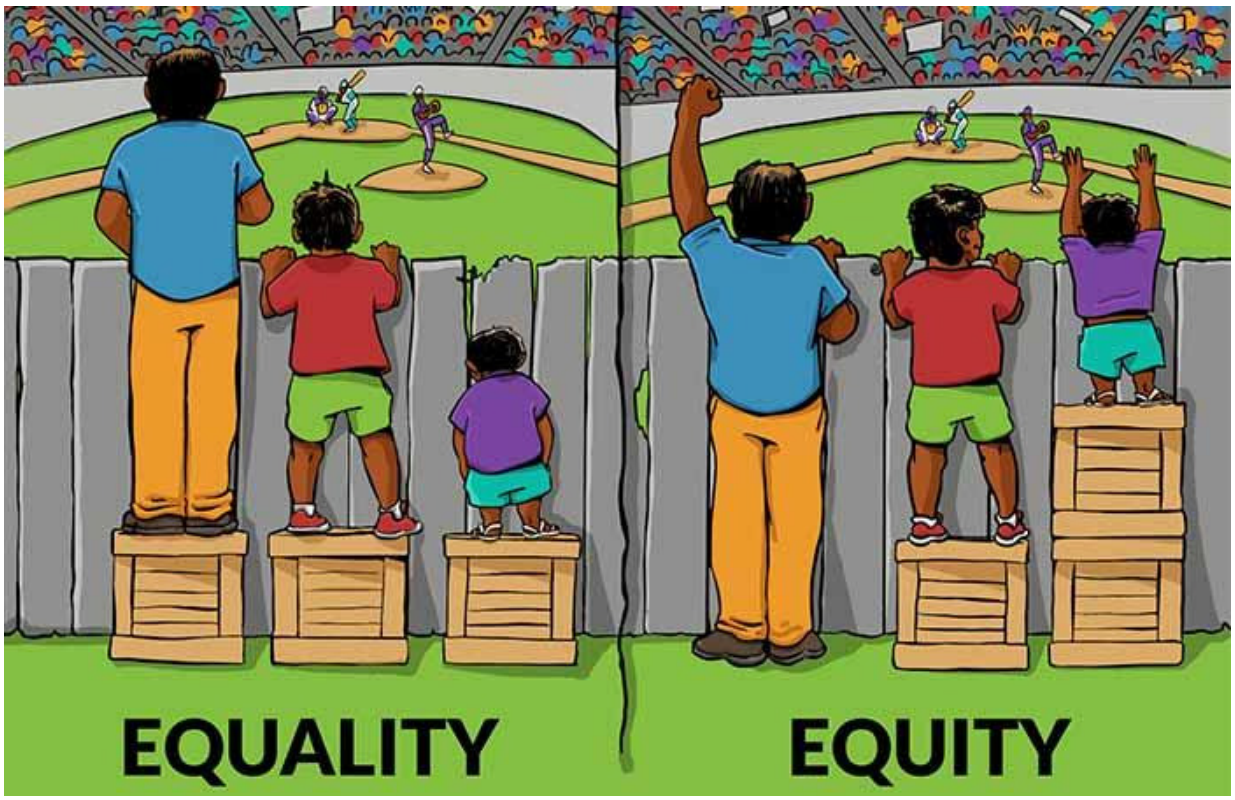


Figure 2 Equality and Equity illustrated All You Need To Know About Gender Equity Accessed on 14/11/2024

Equality does not mean that women and men are the same but that women's and men's rights, responsibilities and opportunities should not depend on whether they are born male or female. Gender equality implies that the interests, needs and priorities of both women and men are taken into consideration, recognizing the diversity of diverse groups of women and men(UN General Assembly, 1979). The centrality of **gender equality** to development is its establishment as a goal (goal 5) of the Sustainable Development Goals (SDGs) and included as a target in other SDGs.

Gender Equity: This is about fairness and being sensitive to the peculiarities of individuals, socio-economic groups, or communities. It is about equality of outcome or result of an intervention. Gender equity involves considering the different social, cultural, and economic situations of women, men, girls, and boys right from the design of an intervention through implementation to monitoring and evaluation.

Gender sensitivity: The ability to recognize the differences in terms of roles, contributions, needs and experiences of both women and men, and create a conducive environment for effective application of their specific knowledge, skills, and experiences in meeting their prioritized needs.

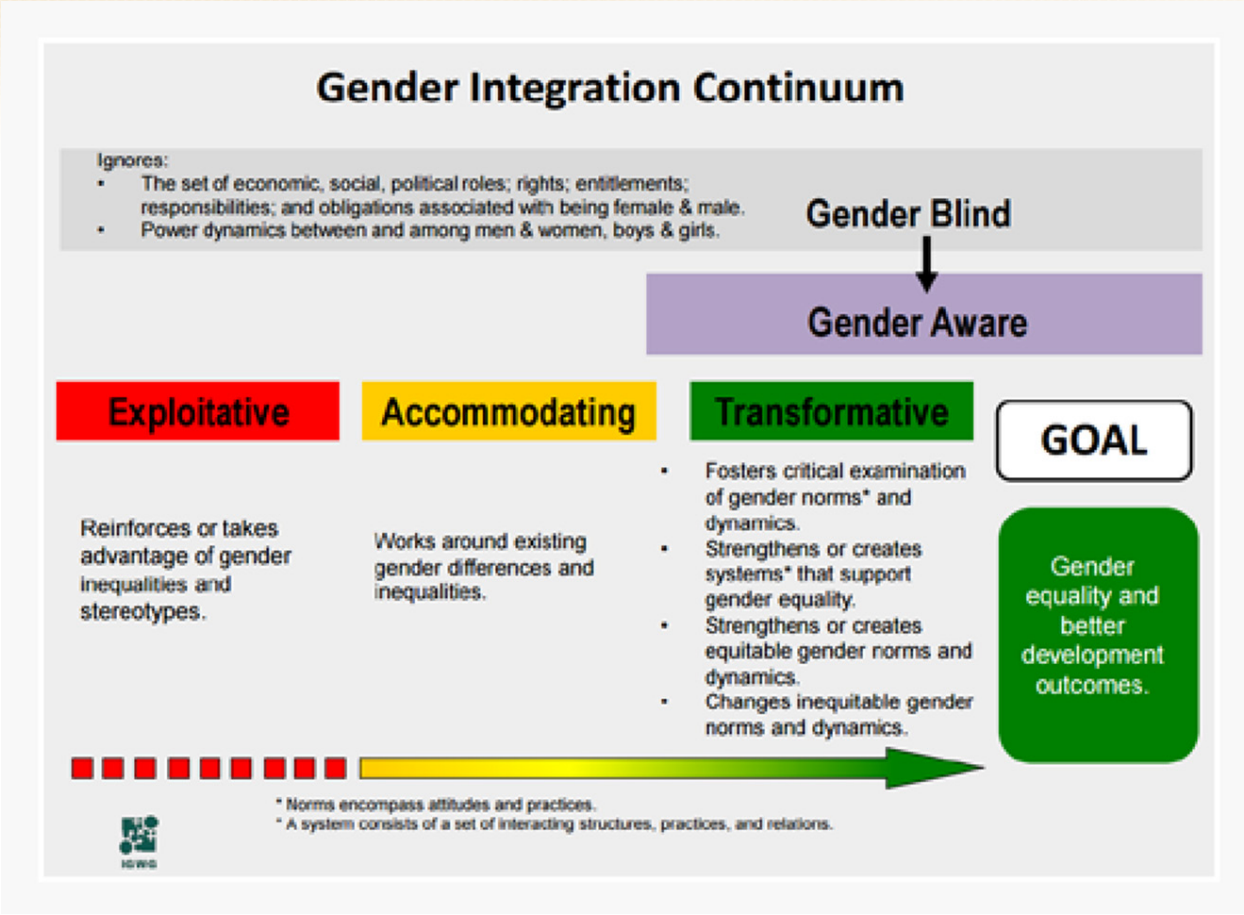


Figure 3: Gender Integration Continuum About IGWG | IGWG *accessed on 14/11/2024*

Gender aware: Recognizing or being aware of the existence of gender and gender differences in society; recognizing that men and women are positioned differently; that they have different experiences, different needs and interests, different strengths, and skills, and that these need to be considered while planning for any intervention.

Gender responsiveness: This describes the policies, programmes and projects that focus on transforming existing gender disparities to create a more balanced relationship between women and men in terms of power and decision-making as well as access to and control over productive resources. Gender responsiveness is key in meeting strategic gender needs(strategic gender needs are the needs women identify because of their subordinate position in society. These needs are long-term and relate to the empowerment of women. Strategic gender needs for women might include land rights, more decision-making power, equal pay, and greater access to credit. Addressing these needs allows people to have control over their lives beyond socially defined restrictive roles)

Practical gender needs are defined as: Needs that respond to immediate necessities such as adequate living conditions, water provision, health care, and employment. Gender-specific needs that do not challenge gender roles, such as access to healthcare, water availability, and employment opportunities.

Gender transformative

Addressing gender imbalances, changing gendered power relations, and actively building equitable social norms and structures. An organization is aware that women and men do not have equal opportunities in the household, at community level or at work. They may, for example, create equal

based violence (GBV). Gender transformative approaches are characterized by explicitly centering gender norms and are thus common for interventions that have the primary goal of addressing gender issues and transforming gender relations to promote equality.

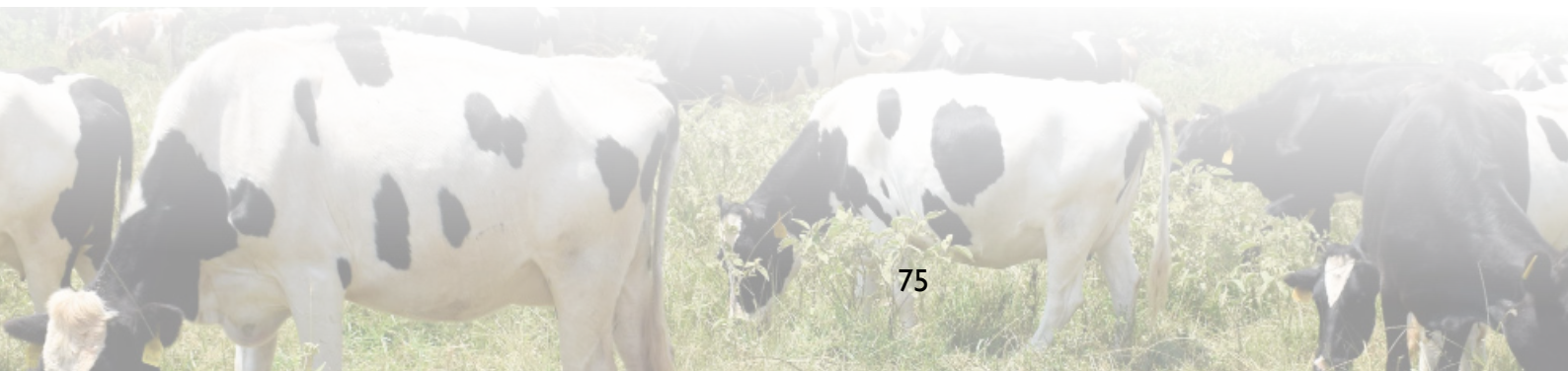
Transformative Gender Programming includes policies and programs that seek to transform gender relations to promote equality and achieve program objectives. This approach attempts to promote gender equality by:

1. fostering critical examination of inequalities and gender roles, norms, and dynamics,
2. recognizing and strengthening positive norms that support equality and an enabling environment,
3. promoting the relative position of women, girls, and marginalized groups, and transforming the underlying social structures, policies and broadly held social norms that perpetuate gender inequalities.
4. Most importantly, program/policy planners and managers should follow two gender integration principles:
    - First, under no circumstances should programs/policies adopt an exploitative approach since one of the fundamental principles of development is to "do no harm."
    - Second, the overall objective of gender integration is to move toward gender transformative programs/policies, thus gradually challenging existing gender inequities and promoting positive changes in gender roles, norms, and power dynamics.

Empowerment: Is about improving women's and men's status to enhance their decision making-capacity at all levels. It refers to the process in which women and men reflect upon their reality and question the reasons for their situation in society. It includes developing alternative options and taking opportunities to address existing inequalities. It enables them to live their lives to the fullest of their capabilities and their own choices in respect of their rights as human beings.

Gender Mainstreaming: Gender equality can be achieved by a strategy of mainstreaming which is defined by the United Nations, as '…the process of assessing the implications for women and men of any planned action, including legislation, policies, or programmes, in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic, and societal spheres so that women and men benefit equally, and inequality is not perpetuated. The goal is to achieve gender equality.'

Gender mainstreaming aims to ensure that women and men, particularly those who are disadvantaged, equally participate in and benefit from the activities of a given organization, and that all implemented projects and programmes consider women's and men's concerns and experiences as an integral dimension of their cycles. This intervention ensures that existing democratic relations are protected, at the same time preventing the further perpetuation of inequalities and the creation of new ones.



11.1.2 The Business case for gender mainstreaming

Gender mainstreaming in Agri-enterprises is not only a matter of social equity but also makes strong business sense. Here are some key points that highlight the business case for gender mainstreaming in this sector:

Increased Productivity: Women make up a sizable portion of the agricultural workforce. By providing them with equal access to resources such as land, credit, and training, productivity can be significantly increased. Studies have shown that closing the gender gap in agriculture could increase yields on women's farms by 20-30%

Enhanced Innovation: Diverse teams bring varied perspectives, leading to more innovative solutions. Women often bring unique insights into agricultural practices and market needs, which can drive innovation and improve business outcomes.

Market Expansion: Women are key players in local markets and value chains. By empowering women, Agri-enterprises can tap into new markets and consumer bases, enhancing their market reach and profitability.

Improved Financial Performance: Companies that invest in gender equality tend to perform better financially. Gender-diverse companies are more likely to have higher returns on equity and better financial performance overall.

Risk Mitigation: Gender mainstreaming can help mitigate risks associated with labor shortages and community relations. Empowering women can lead to more stable and resilient communities, which in turn supports sustainable business operations.

Compliance and Reputation: Increasingly, investors and consumers are looking for companies that adhere to social responsibility standards. Gender mainstreaming can enhance a company's reputation and compliance with international standards, attracting more investment and customer loyalty.

By integrating gender mainstreaming into their operations, Agri-enterprises can not only contribute to social equity but also enhance their competitiveness and sustainability.

8.1.3 Steps to mainstream Gender

Gender mainstreaming in Agri-enterprises involves several strategic steps to ensure that gender considerations are integrated into all aspects of the business. Here are some specific strategies:

1. **Conduct Gender Analysis**: Start with a thorough gender analysis to understand the distinct roles, needs, and challenges faced by men and women in the agricultural sector. This analysis should inform all stages of project planning and implementation.

2. **Develop Gender-Responsive Policies:** Create policies that promote gender equality and address specific barriers faced by women and youth. This includes policies on equal access to resources, decision-making, and opportunities for training and development.

3. **Capacity Building:** Provide training and capacity-building programs for both men and women to enhance their skills and knowledge. This can include technical training, leadership development, and financial literacy.

1. **Monitoring and Evaluation:** Establish gender-sensitive indicators and regularly monitor and evaluate the impact of gender mainstreaming activities. This helps in assessing progress and making necessary adjustments.

2. **Promote Women's Leadership:** Encourage and support women to take on leadership roles within the enterprise. This can be achieved through mentorship programs, leadership training, and creating an enabling environment for women leaders.

3. **Address Social Norms:** Work on changing discriminatory social norms and practices that hinder gender equality. This can be done through community engagement, gender transformative approaches including Gender action learning systems(GALS), community conversations, model families, among others that seek to address root causes of discrimination.

11.2 HUMAN RIGHTS

Human Rights: These are rights inherent to all human beings, independent of nationality, place of residence, sex, national or ethnic origin, race, religion, language, or any other status. All human beings are equally entitled to human rights without discrimination. These include the right to life, equality before the law, the right to work, social security, education, and the right to development. These rights are all interrelated, interdependent and indivisible(Access the comprehensive text here [30 articles on the 30 Articles of the Universal Declaration of Human Rights | OHCHR]

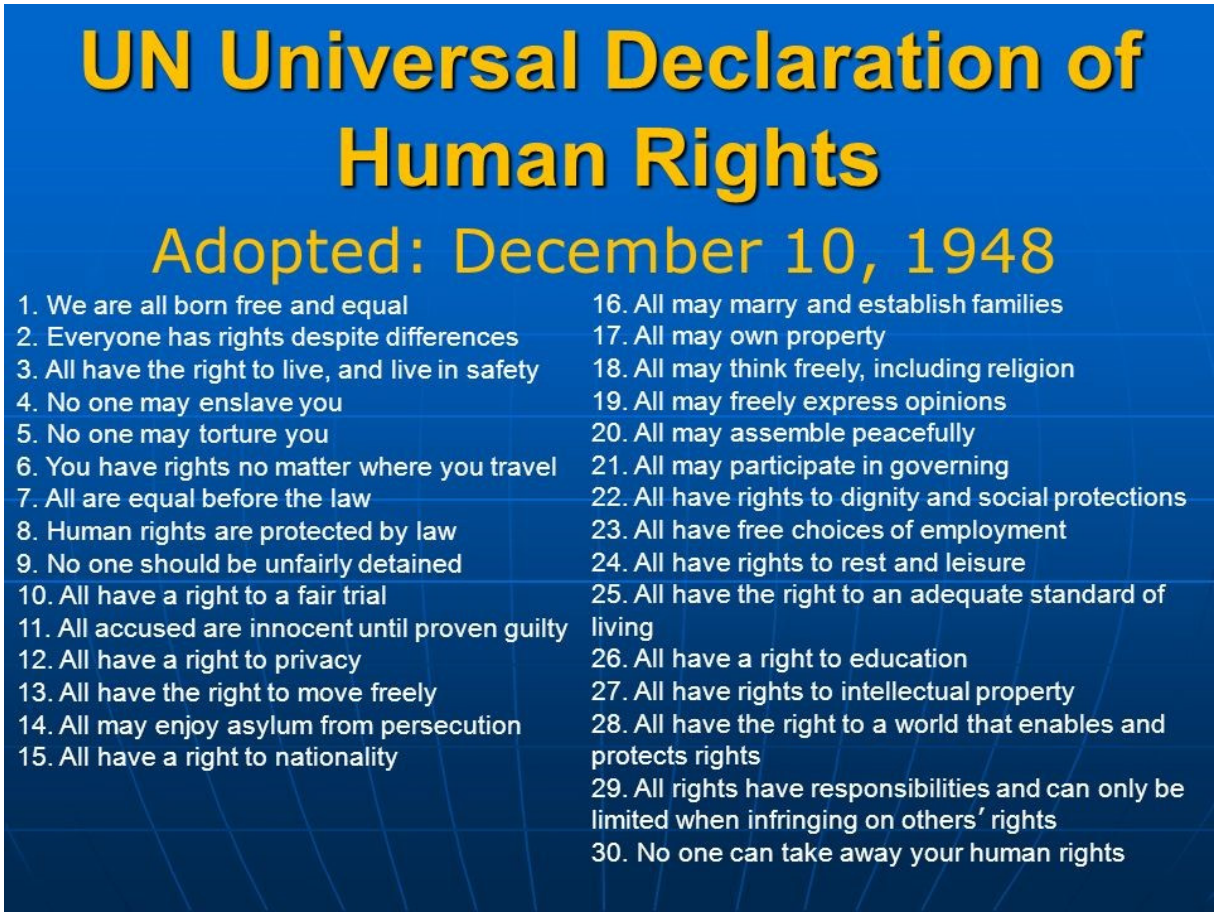


Figure 4: 30 articles of Huma rights https://rvalibrary.org/shelf-respect/law-library/national-human-rights-month/ Accessed on 14/11/2024

Children rights are also enshrined in the convention on the rights of the child(1989). Kenya enacted

convention-rights-child-text-child-friendly-version.pdf accessed on 13/11/2024.

Access the full text here file

A human rights-based approach (HRBA): This is a conceptual framework based on international human rights standards and directed towards promoting and protecting human rights. HRBA seeks to analyze the inequalities which lie at the heart of development problems and redress discriminatory practices and unjust distributions of power that impede development progress.

HRBA is concerned with empowering people to know and claim their rights and increasing the ability and accountability of individuals and institutions who are responsible for respecting, protecting, and fulfilling rights. The HRBA approach aims to eliminate or at least diminish the impediments of existing exclusion and discrimination within the implementation of any programme or project. HRBA

achieve these goals. So, within HRBA, the processes that enable the participation and inclusion of all stakeholders are important.

11.2.1 ABOUT HRBA AND PANT PRINCIPLES

The HRBA builds on the norms and principles outlined in the Universal Declaration of Human Rights, and the subsequent legally binding UN treaties, which form the basis for all development cooperation. Application of the HRBA contributes to effective development cooperation processes and sustainable development outcomes. It challenges unequal power relations and social exclusion that deny people their human rights and often keep them in poverty and oppression. Microenterprise support Programme Trust (MESPT) is committed to the HRBA in all interventions.

HRBA places people living in poverty and oppression (rights holders) at the center. It is about:

- Empowering rights-holders to enable them to take action to address their situation and to claim their rights individually and collectively.
- Developing capacities and interests of duty-bearers to fulfil their obligations to respect, protect and fulfil human rights.

PANT is a tool that guides staff on the practical application of the HRBA.

It has four elements:

Participation : Do all stakeholders engage actively, in a way which allows rights-holders to contribute meaningfully and influence processes and outcomes?

Everyone has a right to freely participate in decision making that affects them and their environment. People of power have an obligation to offer meaningful participation and consultations to people affected. Everyone has the right to organize and hold opinions without any interference, and to seek, receive and impart information and ideas through any media regardless of frontiers. Promoting participation is essential for the outcome of projects and programmes. It is stated in international treaties that women, men, girls, and boys have a right to participate in decision-making that affects them. Social and cultural roles that are prescribed women and men have impact on their possibilities of choices, economic independence, access to natural resources, access to land tenure, access to clean and safe water, and decisiveness on housing, education, and livelihood.

Guiding questions are:

- Are fair and effective platforms for public-private dialogue in place, and do they give space to representatives of women and men with less power and status?
- Are measures taken to include and enhance the capacity of those with less knowledge and power so that they can participate meaningfully in the consultative processes? For example, do all stakeholders have sufficient and accessible information on the issues being addressed? Are they invited to truly participatory processes? Are barriers removed, e.g., no expensive travelling, not during busy seasons, not inaccessible for women or persons with disabilities?
- Are stakeholders actively engaged at all stages of the programming process?
- Do initiatives make space for vulnerable people to take actions of their own choosing to manage per-

- The state has an obligation to respect, fulfil and protect the rights of its population. It entails a functional regulatory system for climate and environmental issues, labour law, land systems ; concrete plans for disaster risk reduction and response; rule of law including a justice system providing legal aid to poor and marginalized people and their organisations; and functional and accessible complaints mechanisms. Emphasizing the accountability of all actors (both state and non-state), whose actions impact the environment and natural resources, is a central element of HRBA. Asserting human rights without supporting effective and precise frameworks to hold duty bearers accountable is of little practical use. Strengthening the governance of natural resource management and securing natural resources tenure while also taking rights of local people, women and men, ethnic minorities, nomadic or other marginalized groups into account, can
- minimize corruption.
- have positive effects on conflict management.
- be a key step towards alleviating tensions in society and consolidating peace in post-conflict societies.
- **Guiding questions are:**
- Are the duty bearers and other actors with power identified?
- Does the initiative contribute to ensuring that public and private sector actors have systems in place to monitor and disclose social and environmental impacts according to national and international standards?
- Do monitoring and evaluation arrangements involve civil society organisations representing the concerned population?
- Are there consequences (legal, financial, or moral) for non-compliance with human rights objectives and principles?
- Has the contribution established accessible and effective mechanisms for redress and complaints?
- Does the contribution facilitate access to networks, organisations and other sources of information that may assist duty bearers to enhance their accountability and rights holders to claim their rights?

Non-discrimination :Are rights holders and the root causes of their lack of human rights identified and considered, particularly those most subjected to discrimination, marginalization, and vulnerability?

All women, men, girls, and boys are, without any discrimination, entitled to equal access to ecosystem services , market systems and natural resources as well as resilience for a standard of living adequate for their health and well-being. Discrimination may be expressed in law (explicit discrimination) and hence be part of official policy such as lack of land rights; or it may be found in practice and behavior (implicit discrimination)such as where a remote group cannot access water services because drinking wells provided by the state are too far away.

Key questions are:

- Are vulnerable groups specifically identified and targeted?
- Is there a proper analysis of the consequences of the contribution for these women, men, girls, and boys?
- Is there a plan for their inclusion and benefit including disaggregated data and indicators?
- Are tariffs and fees also adjusted to accommodate poor and marginalized groups?

Transparency :What measures are put in place to ensure that all stakeholders can access relevant information and knowledge regarding the contribution?

Transparency All people have the right to obtain information in an accessible and timely manner, e.g., about pollution levels, water quality, environmental health risks, exploitation plans, land use plans and disaster preparedness plans. Granting sufficient and accessible information to affected women and men in planning and policy making processes is of key importance to their ability to influence and monitor developments. It is also important to consider local traditions, survival strategies and indigenous people's dependence on natural resources, and ensuring that separate views are documented. It is also essential to consider access to natural resources for people living in poverty and that a long-term sustainable development can be promoted, to avoid future opposition and conflicts.

Guiding questions are:

- Are the plans and goals of the contribution made public and explicit in an accessible manner to all stakeholders concerned, including the most marginalized groups so that they understand benefits and risks?
- Will affected women, men, girls, and boys receive sufficient, timely and accessible information, including separate views on the plans, and will they be able to take meaningful part in and influence the process?
- Will access to information regarding the local risk situation be improved and will early warning systems be developed so that the ability of vulnerable groups to protect themselves and quickly recover after disasters is strengthened?
- Does the initiative contribute to capacities and commitments for greater transparency in policies and practice affecting land and natural resource tenure, particularly in new forms of land acquisitions and concessions?

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ANNEX I

MESPT
MICRO ENTERPRISES SUPPORT PROGRAMME TRUST

DAIRY VALUE CHAIN TRAINING WORKSHOP FOR XXXX

TRAINING VENUE: XXX **DATES: XXX**

SAMPLE PROGRAMME

Date and Time	Activity	Duration	Responsible

ANNEX 11.: List of participants who validated this value chain manual

S/NO	NAME	INSTITUTION
1	Joseph Kairu	County Government of Siaya
2	Winston Motanya	County Government of KISII
3	Nicholas Manyinsa	County Government of KISII
4	Cecilia Mutuku	County Government of MACHAKOS
5	Paul Busienei	County Government of NAKURU
6	David Kimera	Youth Agri-Preneur
7	Lawrence Swanya	County Government of MACHAKOS
8	Kenneth Kagai	County Government of TRANS-Nzoia
9	Benedict Khanyifu	County Government of TRANS-Nzoia
10	Mwalimu Menza	Kenya Agricultural and Livestock Research Organization
11	George Kamami	County Government of MAKUENI
12	Moses Munialo	County Government of BUGOMA
13	Agesa Eric	County Government of KAKAMEGA
14	Benard Mainga	County Government of KWALE
15	Jane M Kamamu	County Government of KILIFI
16	Teresia Ndungu	County Government of NYANDARUA
17	Wilbur Mutai	County Government of UASIN-GISHU
18	Stephen Odipo	Kenya Agricultural and Livestock Research Organization
19	Solomon Mbivya	PAPA FARMERS Limited
20	William Mwangi	County Government of MAKUENI
21	Doreen Kinoti	Micro-Enterprises Support Programme Trust
22	Serah Nzau	Micro-Enterprises Support Programme Trust
23	Margaret Kikuvi	Micro-Enterprises Support Programme Trust

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