MODULE 9

Dairy Production

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1 INTRODUCTION

By paying close attention to various practices and implementing appropriate and specific management systems for feeding practices, the use of available facilities, and good sanitation, milk production can be increased to relatively high levels. This module will assist extension officers in assisting small-scale and subsistence farmers with pest and disease management as a result of climate change. The demand for more milk in South Africa, and indeed the world, is constantly increasing (Rojas-Downing, 2017); producing more milk per adapted cow in a climate-smart way means reducing greenhouse gas emissions. Pest and disease management that is climate-smart is a big part of that.

Each region and each dairy farm are affected differently by climate change. Site and context specific dairy climate-smart approaches exist, and there is no one-size-fits-all solution for all situations. We can, however, define some general guidelines to follow and provide examples that readers can adapt to their own situations. Climate change, land and water competition, and food security are all likely to have a negative impact on dairy production at a time when it is most needed.

Greenhouse gas (GHG) emissions, which result in atmospheric warming, are the primary cause of global climate change. In the livestock sector, intensified systems, such as dairy farming, account for 14.5% of global GHG emissions, potentially worsening land degradation, air and water pollution, and biodiversity loss. Equally, climate change will impact livestock production through competition for natural resources, feed quantity and quality, livestock diseases, heat stress, and biodiversity loss, while demand for livestock products is expected to double by the middle of the twenty-first century. Therefore, maintaining a balance between productivity, household food security, environmental preservation, and animal welfare is a challenge.

Training structure

In this module, you'll learn about Climate-Smart Agriculture (CSA) and what it means to be climate-smart. You'll also learn about weather and climate, climate variability, climate change and global warming. How climate change affects dairy farming will also be explored..

Training objectives

After completing this module, participants will have a working knowledge of key CSA practices and will be able to answer the following questions:

- What is climate change?
- How does climate change affect dairy farming?
- Dairy feed and feeding
- Adapting dairy cows to hot weather
- Climate-smart water management practices
- Dairy cow grazing management
- Calf rearing

2 WHAT IS CLIMATE CHANGE?

2.1 WEATHER AND CLIMATE

To understand what climate change really means, it is important to first differentiate between weather and climate.

- **Weather** refers to the state of the atmosphere at a specific location and time. Rain, humidity, wind, sunshine, cloudiness, and temperature are the most common aspects of weather that everyone experiences throughout the day, but extreme events such as tornadoes, droughts, and tropical cyclones are also common. Weather is dynamic, and it can change dramatically in a short amount of time, even within a single day
- **Climate** is the set of weather conditions that prevail in an area over a long period of time, typically three decades (IPCC, 2007). Long-term averages of temperature and precipitation, as well as the type, frequency, duration, and intensity of weather events such as heatwaves, cold spells, storms, floods, and droughts, all contribute to the definition of climate

2.2 CLIMATE VARIABILITY

Climate variability refers to the natural fluctuation of the climate, which includes swings above and below the mean state as well as other variables. It depicts the various weather conditions over the course of a day, month, season, or year. For example, if we look at rainfall over a period of time in a specific region of the world, the variability can be low, implying that there is little variation in the amount or timing of rains from one year to the next. In another region, rainfall quantity may be highly variable, ranging from far below average to far above average from year to year, with unpredictable timing. Climate variability has an impact on weather conditions such as cyclone activity, temperature, and rainfall. Natural internal processes within the climate system, such as the El Nio Southern Oscillation (ENSO) or the Atlantic Multidecadal Oscillation (AMO; Box 1), or natural external forces, such as volcanic eruptions, cause climate variability.

Box 1. Example of climate variability - AMO

The Atlantic Multidecadal Oscillation (AMO) is a mode of variability in the North Atlantic defined by sea surface temperatures. With only a few shifts between its warm and cool phases in the twentieth century, it is a longer-term source of variability. Temperature and rainfall patterns in North America and Europe, as well as Brazil, the Sahel, and India, have been linked by scientists. According to research, the AMO has an impact on hurricane activity in the Atlantic.

2.3 CLIMATE CHANGE

The main distinction between climate variability and climate change is that climate change is indicated by a trend over time. Climate variability is defined by fluctuations over shorter time periods – days, seasons, years, or several years – and in cycles, whereas climate change is defined by a consistent linear trend as patterns shift over decades. When the climate – the long-term pattern of climate variability – and the mean show significant measurable changes, climate change is detected. Over decades, for example, the climate gets warmer or cooler, wetter or drier on average. Climate variability averages out to a steady-state climate over years, whereas climate change averages out to a changing trend over decades (see Figure 1).

2.4 CLIMATE CHANGE AND GLOBAL WARMING

Natural factors such as widespread volcanic activity and oscillations in the planet's rotational and orbital cycles have always caused climate change on Earth. Scientists, on the other hand, have been observing trends toward higher average global temperatures that are occurring at a much faster rate than previously observed and cannot be attributed to natural causes. Rather, scientists believe that this longer-term warming is anthropogenic, or caused by human activity. As a result, the UN Framework Convention on Climate Change (UNFCCC) defines climate change as "a change in climate that is attributed directly or indirectly to human activity, that alters the composition of the global atmosphere, and that is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1992).

Studies show that concentrations of greenhouse gases, which trap heat in the atmosphere, have risen dramatically since the beginning of the industrial era. Industrial-scale production began around 1750, resulting in a global increase in the use of fossil fuels, which emit greenhouse gases when burned. The planet warmed by 0.85 degrees Celsius on average between 1880 and 2012. Temperatures are expected to rise by 0.3 to 4.8 degrees Celsius by 2100, depending on a variety of factors (IPCC, 2013). Each of the last three decades, from 1981 to 1990, 1991 to 2000, and 2001 to 2010, has been warmer at the Earth's surface than any other decade since records began. 2001 to 2010 was the warmest decade ever recorded, and 2016 was the warmest year on record, with a 1.1°C increase over pre-industrial levels (WMO, 2017). Living in the year 2020, it is clear that the previous decade (2011–2020) will be the warmest ever measured – until the next decade surpasses it. Despite the fact that these appear to be minor changes when compared to long-term observations of stable conditions, the shift is noticeable. Long-term global warming causes climate changes at regional and smaller scales, which have significant consequences for the planet's ecosystems.

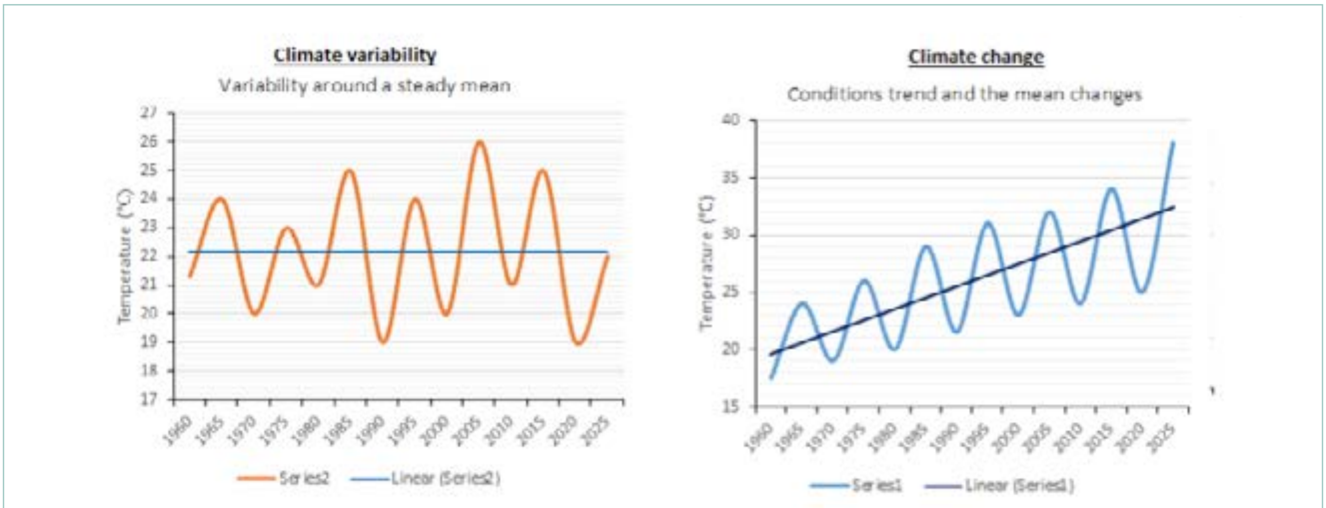

Figure 1 Climate variability and climate change.
Source: Muya ARC.

3 HOW DOES CLIMATE CHANGE AFFECT DAIRY FARMING?

The concentrations of greenhouse gases in the atmosphere are at their highest point in 800,000 years. As a result of their presence in the atmosphere, the Earth's ability to reflect the sun's energy back into space is reduced, causing the surface temperature to rise. The effects of rising temperatures on our rainfall, sea levels, and overall weather patterns are severe.

Climate change has a two-way impact on dairy farming:

- it affects cows and milk production directly, and
- dairy farming contributes significantly to climate change through GHG emissions.

Temperatures in southern Africa are expected to rise by 1.5 to 3 degrees Celsius by 2050. The consequences are already being felt: the 2015 agricultural season was the driest in 35 years, prompting partial drought declarations in eight of South Africa's nine provinces.

Pests and diseases, crop yields, flooding, animal stress, drought effects, and the limited ability to provide sufficient resources for animals during extreme weather events are the most significant impacts of climate change for the dairy industry as a whole.

3.1 CHOOSING THE DAIRY BREED

Choosing the dairy breed can be a difficult decision. However, if you know which breed suits your needs, you will be able to choose and buy the right one. Usually this depends on the quantity of milk that one wants to produce, but also on the resources available as requirements differ from one breed to another.

Dairy production would be climate smart if adaptability of indigenous breeds were fully exploited. This applies more to resource-poor systems; in input-intensive systems the approach would be different. Either way, there is an urgent need to alleviate the negative effects of climate change on livestock production to meet growing demand for livestock products worldwide.

Climate-smart dairy farming is sustainable farming that meets the demand for safe and sufficient milk while preserving ecosystem integrity, and does so by maximizing the net benefit to society after all costs and benefits are taken into account. The genotype of the dairy animal within its environment guides climate-smart dairy farming.

Africa's indigenous breeds and cross-breed animals play a critical role in climate-smart livestock production. Breeds from temperate environments cannot express their full genetic potential in Africa without costly environmental modifications. It is prudent to capitalise on the inherent competitive advantages of indigenous genotypes or more adaptable breeds in order to mitigate climate change.

South Africa is home to a few dairy breeds. These breeds are known for producing more milk and are well-suited to intensive milk production systems like parlour equipment, cow housing, and concentrate feeding.

These should be selected based on their adaptability to the environment (see Figure 2):

- Brown Swiss
- Dexter
- Guernsey
- Holstein-Friesian
- Jersey
- Shorthorn

Figure 2 Dairy breeds found in South Africa.

3.2 ADAPTABLE DAIRY BREEDS

Adaptability to temperature

Heat stress is caused by a combination of environmental factors that result in temperatures that are higher than the animal's thermal neutral zone. Several weather factors, particularly temperature and humidity, influence an animal's survival and performance during heat stress periods (see Figure 3). Feed consumption, milk production, and breeding efficiency are all reduced when animals are exposed to extreme heat for long periods of time.

The degree to which an animal suffers from heat stress is determined by a variety of factors. Among the most important are:

- Temperature and humidity
- Length of the heat stress period
- Degree of night cooling that occurs
- Ventilation and air flow
- The cow's size
- Level of milk production and dry matter intake prior to the heat stress (higher producing animals will experience greater effects of heat stress)
- Type of housing, ventilation, overcrowding, and other factors to consider
- Availability of water
- Colour of the breed's coat (lighter colour coats absorb less sunlight)
- Hair coat thickness

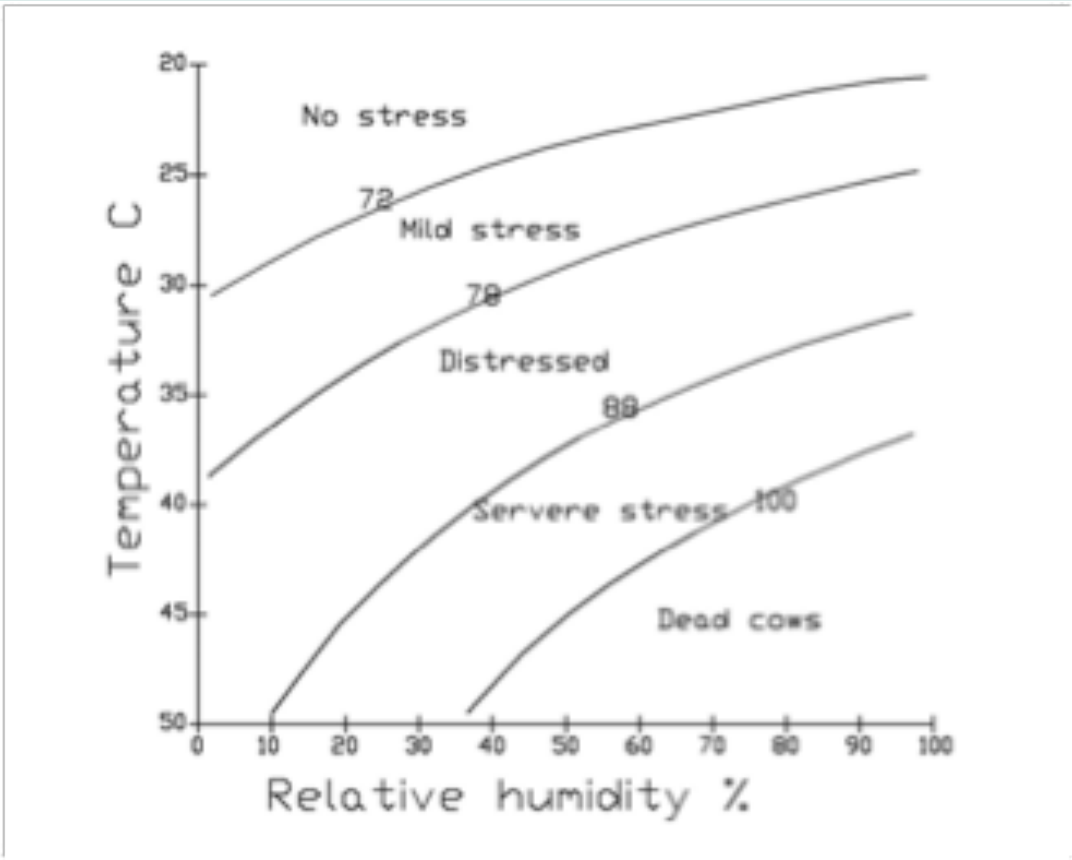

Figure 3 General stress levels at different temperature / humidity indexes.

3.3 STRENGTHENING RESILIENCE OF DAIRY COWS TO CLIMATE CHANGE THROUGH ADAPTATION

The dairy industry's producers and systems have always had to contend with changing weather conditions. The season can be hot or cold, wet or dry in general. Dairy farmers, on the other hand, adjust and usually still produce enough milk to sell. However, the weather can be unusual at times: it can be much hotter, wetter, or drier than usual. The growth of forage and other crops may be hampered, and animals may perish as a result. The average amount of rainfall is decreasing in some areas, and rains are becoming more erratic. Rain is falling more frequently and with greater intensity in other parts of the country.

Adapting to climate change in dairy farming entails enabling dairy producers to deal with such shocks. Dairy farmers' adaptive capacity refers to their ability to implement strategies that help them maximize productivity even in the face of adverse weather conditions.

To reduce the vulnerability of dairy systems, three variables can be changed at the local level and within communities:

i. Lower the farm system's risk. Planting healthy windbreaks and hedgerows, as well as using no-tillage planting techniques, will help soil stay put and resist erosion. Feed that is stored off the ground is safer from floods and vermin.

ii. Reduce the farm systems' sensitivity to these shocks. Drought sensitivity can be reduced by using drought-resistant varieties or having enough hay on hand. Reduce runoff and balance supply and demand by implementing water harvesting, storage, and conservation management techniques.

iii. Improve your adaptive capacity by learning new skills and experimenting with new ideas. This includes taking into account all potential shocks and changes as compensating, exacerbating, and cumulative effects, as well as considering system modifications.

3.4 CLIMATE-SMART DAIRY PRACTICES

Dairy producers must develop their own adaptive capacity in order to thrive in the face of rising climate risk. Many innovative solutions and traditional practices have emerged as potential responses to site-specific circumstances after decades of sharing experiences and refining approaches.

3.4.1 Destocking

Reducing the number of dairy cows as a deliberate decision, rather than as a result of hardships, to improve resilience and make the herd more manageable. The Livestock Emergency Guidelines and Standards (LEGS) are a good resource for destocking advice.

3.4.2 Changing to drought-tolerant livestock species or breeds

Animals that are more drought or disease tolerant can be purchased or bred. This can include changing the animal's type or species. Drought-tolerant species include zebu cattle and small ruminants, to name a few.

4 DAIRY FEED AND FEEDING

The goal of dairy animal nutrition is to ensure that they get enough nutrients for maintenance, growth, pregnancy, and production. Feeds contain a variety of nutrients that the animal requires.

Animals should be fed enough food and water on a daily basis to meet their physiological needs. The animal's age, body weight, lactation stage, production level, growth, pregnancy, activity, and climate should all be reflected in the feed's quality and quantity, which includes appropriate fiber.

To put together a feeding schedule for dairy cows, you must be aware of the animals' needs as well as the feed composition available. In practice, a lack of knowledge about feeds frequently leads to animals being fed too much or too little, resulting in financial losses.

Roughage (hay, silage, pasturages, and straw) and concentrates are the two types of feed for dairy cows (maize, wheat, etc.).

For dairy cows, grazing is usually the cheapest source of roughage. The energy content of crops and their high moisture content are two factors that limit milk production from grazing. Pastures can be a good source of nutrients if they are well-managed. For high-producing cows, more grain is required.

Silage crops are the most cost-effective way to store roughages. Maize is primarily used for silage production. Most grasses and legume plants can be used to make high-quality silage. Silage has a high moisture content and is therefore bulky. Silage often has a higher crude protein content than hays.

4.1 CLIMATE-SMART DAIRY FEEDING PRACTICES

4.1.1 Dairy feed supplements

Potassium, sodium, and chlorine are all minerals that help to reduce the effects of heat stress. Saturated fatty acids can also be used to replace rapidly fermentable carbohydrates like maize.

4.1.2 Improved feed management

- Storing animal feeds such as silage and stover, making better use of feeds (by combining them), growing grass varieties better suited to the agro-ecological zone, fodder conservation, and fattening animals are just a few examples.
- Higher feed density, no feed ingredient separation, better bacteriological quality, easier ingestion, and improved growth and feed conversion ratio are all advantages of pelleting. Always have fresh, clean water and good quality hay, such as *Eragrostis*, on hand
- Feeding weaned heifers according to age and weight in groups makes for more efficient feeding practices. Having fresh hay on hand at all times.
- Feeding the lactating dairy cow
    - Improve feed efficiency by optimizing feed energy and protein content.
    - Use precision feeding techniques to match animal needs to nutrient supply
    - Make use of locally produced feeds and look for low-emission feeds such as local by-products.
    - Offering a Total Mixed Ration (TMR) or pasture-based feeding are the two main feeding options at this stage.

Figure 4 Concentrate mash and pellet.

Figure 5 Heifers fed grass / concentrate.

4.2 TOTAL MIXED RATIONS (TMR)

These animals can graze and be supplemented with concentrate to compensate for pasture deficits, or they can be fed a complete feed called TMR, depending on the system used (total mixed ration). TMR is a formulated and mixed mixture of roughage and processed ingredients (concentrate), formulated and mixed to meet the needs of the cow in a form that prevents selection. A constant supply of fresh, clean water is required.

Total mixed ration

TMR can be made up of a variety of ingredients that are chosen based on their availability, nutritional value, and cost, with the main goal of obtaining a well-balanced ration at a low cost.

EXAMPLE: TMR formulated to meet the minimum requirements of a 680 kg Holstein cow in early lactation producing 40 kg of milk with 4% fat and 3.5 percent protein:

High energy concentrate (19% CP):	12.6 kg
Cotton seed :	2.2 kg
Lucerne hay:	4.0 kg
Molasses meal:	2.3 kg
Eragrostis hay:	3.0 kg
Water:	13.0 kg

The concentrate (mash or pellet) must be a mix prepared for a lactating cow. However, not any mash or pellet can be used. The concentrate is designed to meet the nutritional needs of young, adult, pregnant non-lactating, and lactating dairy animals, which vary.

Cotton seed (whole) is a good protein and energy supplement for lactating cows when fed whole. It should not be fed at more than 3 kg per cow per day.

Lucerne hay is the best-known legume hay. It has a pleasant taste and is generally beneficial in almost all rations. It has a high protein content in general, but it is low in energy. It goes well with maize silage, maize, and molasses as a feed. There are no limitations on the degree of inclusion. It should, however, be avoided during the dry period in cows that are prone to milk fever due to its high calcium content.

Molasses meal is a source of energy that is made up of bagasse and molasses. It enhances palatability and has good binding properties.

Eragrostis curvula is most commonly used as hay. Under favorable weather conditions, it can be cut, dried and baled on the same day (see Figure 6).

Maximum feed intake should be achieved in order to support milk production and minimize body weight loss.

TMR can be prepared using a feed mixer which cuts the hay and thoroughly mixes the ingredients. Water is then added is to improve intake and prevent feed selection (Figure 7).

Figure 6 Dairy feed ingredients.

Figure 7 Mixing feed and feeding using a mixing wagon.

4.3 CLIMATE-SMART DAIRY FEEDING PRACTICES (PASTURE)

Maximising the use of natural pasture

The quantity and distribution of rainfall, as well as seasonal variations in the natural pasture feed base, are all factors that influence veld quality. When grass is scarce, cross-breeds become browsers. Dairy production on natural pasture uses less water than dairy production on cultivated pastures, lowering the water and carbon footprints of such products.

Climate change puts a strain on dairy production by promoting heat stress, which results in a variety of behavioural, chemical, physical, nutritional, physiological, and metabolic responses as the animal's physiology tries to maintain cell integrity in order to survive.

4.4 MITIGATION STRATEGIES TO REDUCE GHG EMISSIONS

The increase in GHG emissions from human activity is raising average temperatures, which may lead to vegetation shifts in which nutritious plants are eventually replaced by desert-adapted, woody plants whose stomata remain closed during the day to reduce evapotranspiration but open at night to collect carbon dioxide (CO_2). Changes in the composition of grass species erode the feed base. Its replacement with less digestible forages with a higher methane conversion rate has the potential to increase GHG emissions.

Ruminants, which include livestock such as dairy cows, occupy 45% of the world's ice-free land area due to their ability to convert grass, shrubs, and foliage into food and fibre. Livestock farming contributes between 7% and 18% of human-induced GHGs, specifically enteric fermentation, manure, feed production and transportation, and land use change. Indeed, feed accounts for 65 to 75% of variable costs in livestock enterprises, and feed production accounts for 47% of GHG emissions from livestock farming.

Strategies that improve forage quality and digestibility can help to mitigate this. Improving forage quality improves digestion and decreases enteric methane (CH_4) excretion, increasing feed efficiency.

There are three types of enteric CH_4 mitigation interventions in dairy farming:

1. Dairy cow feeding and nutrient management
2. The application of rumen modifiers.
3. Management and genetics.

Research yields technologies that increase production efficiency while consuming less feed and water per unit product. Strong associations between enteric CH_4 production and dry matter intake (DMI) in cattle fed temperate forages have been reported as early as 1930.

Methane production in cattle fed tropical forage diets is higher, especially at higher intake, than in cattle fed temperate forages, owing to the latter's low digestibility. As a result of improved digestibility, improved forage quality reduces lifetime GHG emissions per unit product.

Manipulation of rumen fermentation

Feed additive supplementation alters the pattern of feed fermentation in the rumen of the dairy cow and reduces enteric CH_4

excretion. When enteric CH_4 production can be reduced while maintaining productivity, more feed energy is partitioned into intermediary metabolism for productive purposes, increasing efficiency. Enteric methanogenesis degrades feed efficiency and should be reduced to reduce global warming without jeopardising rumen function (see Figure 8):

- Some feed additives increase feed dry matter intake while decreasing acetate production and hydrogen release
- Ensiling forages at earlier stages of regrowth improves digestive efficiency and reduces GHG emissions, while grinding and pelleting forages before feeding reduces GHG emissions
- Precision nutrition reduces GHG emissions and excreta volume, benefiting both the climate and the environment

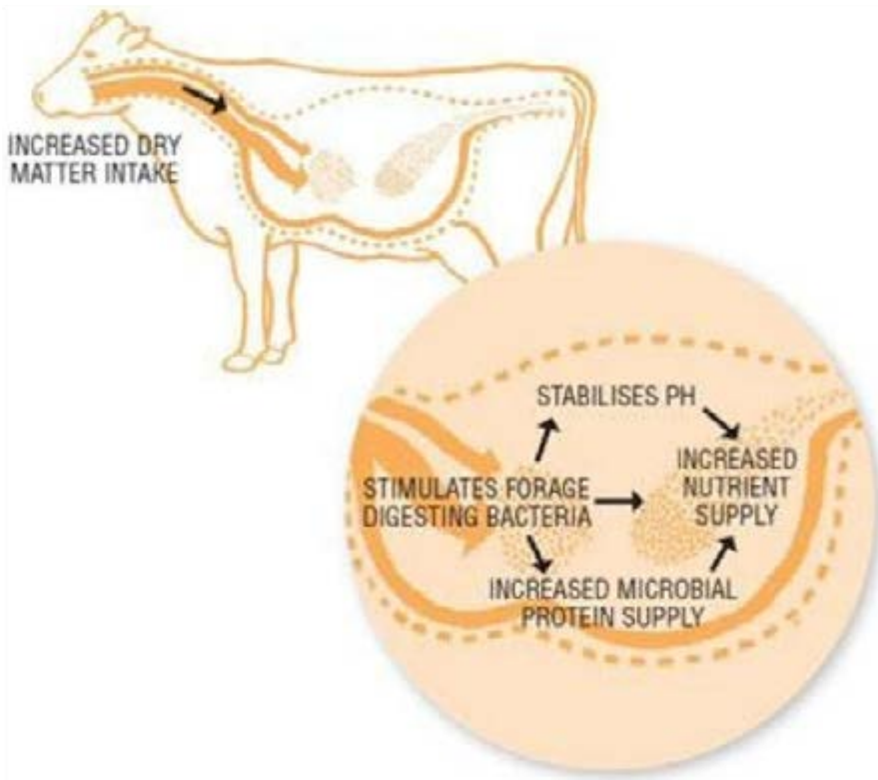

Figure 8 Effects of increasing feed intake.
Source: Lallemand and Nutrition.

- Gene expression can be controlled by diet at any point along the pathway, from gene packaging and unpacking of DNA to protein processing and degradation, using nutrigenomics. This allows for the optimisation of livestock diets in accordance with their genetic potential, physiological and production states
- Climate-smart breeding programs that use heat stress-tolerant genotypes with above-average production efficiency and low carbon and water footprints per unit product are also needed

EXAMPLE: According to the United States Department of Agriculture, the global number of dairy cows fell from 133 million to 125 million between 1997 and 2007, while milk production increased from 377 to 418 million tons. This represents an 18% increase in milk production efficiency over a 10-year period.

The following are the keys to maximise feed intake:

- Regular checking and cleaning of the water troughs ensures that fresh, clean water is always available.
- Ensure that feed troughs are not empty before the next feeding session, and that adequate feed is provided: daily scoring of feed troughs for remaining feed.
- Cleaning feed troughs on a regular basis (e.g., once a week).
- Remove rotten feed as soon as possible because it will quickly infect new feed and animals will refuse to eat it.

Efficiency improvements would go a long way toward mitigating the effects of climate change and increasing production of affordable, nutritious livestock products.

5 ADAPTING DAIRY COWS TO HOT WEATHER

5.1 MANAGEMENT STRATEGIES

The physical modification of the environment, the genetic development of less sensitive breeds, and improved nutritional management are the main management strategies that can be proposed as being helpful in alleviating heat stress in dairy cows. Mechanical cooling, such as forced ventilation, water sprayers, and shading, may be used to mitigate the effects of increased temperature. These, however, are difficult to apply to dairy cattle on pasture and provide only limited relief in the short term.

5.2 METHODS TO COOL THE COWS AND THEIR ENVIRONMENT

Cooling fans

The first step in cooling cows is to strategically place cooling fans (Figure 9). During stressful conditions, air flowing over the animal at a velocity of 2-3 m s^{-1} increases convective heat loss. Fans should be installed longitudinally in holding areas and free stall shelters, no more than 10 times their blade diameter apart. Vertically, they should be just high enough to be out of reach of the cattle while not interfering with alley scraping or bedding operations.

Figure 9 Cooling fan.

Sprinkler and fan cooling

Sprinkler and fan cooling is a popular method for cooling dairy cattle due to its low investment costs and high effectiveness (Figure 10). The air is not cooled by a sprinkler system. Instead, large droplets wet the cow's hair coat and skin, cooling it as the water evaporates. Sprinklers alone will not keep cows cool in hot, humid weather. However, when the sprinkler system is combined with forced air movement, the loss of body heat increases by a factor of three or four. This cooling system operates at timed intervals that vary depending on the weather. In hot, humid climates, sprinkler and fan cooling are popular. It should be noted that this system uses a lot of water and leaves a lot of water on the floor, which can lead to foot problems.

Figure 10 Sprinkler and fan cooling.

6 CLIMATE-SMART WATER MANAGEMENT PRACTICES IN DAIRY FARMING

6.1 WATER HARVESTING FOR FARM PRODUCTION

Water harvesting is the capture of rainwater or groundwater for crop, livestock, and aquaculture production (see Figure 11):

- Water is usually abundant during the rainy season and scarce during the dry season.
- Water is the most constraining factor in crop, livestock, fish, and fodder production.
- Water harvesting and irrigation allow crops or fodder to be grown in the face of insufficient rains or outside of growing seasons.
- Harvesting water for irrigation improves production efficiency (output per unit input) and provides crop/fodder all year..

Dam and ponds

A pond-integrated system begins with the catchment for harvesting water, which is typically found along a road or within a farm, followed by the sill trap, screen sill filter, and excavated pond (see Figure 12).

Figure 11 Water harvesting.

Figure 12 Pond.

Other strategies

Zai Pits, retention ditches, and basins can all be used. A Zai Pit is a water harvesting method that originated in Kenya. Zai pits are referred to in English as "planting pockets," "planting basins," "micro-pits," and "small water harvesting pits." This entails digging planting pockets of specific dimensions to collect surface runoff water. These pits also attract termites, whose tunnels help break up the soil even more. After filling the pits with one to three handfuls of organic material such as manure, compost, or dry plant biomass, seeds are sown in them. Water percolates through these pits, keeping the plants green for an extended period of time. (Sawadogo, 2011)

6.2 DAIRY MANURE MANAGEMENT

It is critical to limit direct exposure of dairy manure prior to proper disposal. This is due to the fact that the amount of GHG emissions from manure (CH_4, N_2O, and NH_3 from liquid manure) is affected by the temperature, method, and duration of storage. Some of the key considerations in manure handling that affect GHG emission intensity are as follows:

- Dairy waste (dung and urine) should be collected and stored as soon as possible
- Reduced storage duration is critical because long-term storage results in higher GHG emissions
- The rate of GHG emissions during manure storage is affected by heat levels; at high temperatures, more gases are emitted than at low temperatures

Figure 13 Zai Pit.

- The use of covered storage facilities can help to reduce GHG emissions
- Composting reduces direct GHG emissions into the atmosphere. In this case, the manure will be covered and then decomposed into less harmful gases
- Improved application techniques, such as rapid incorporation of manure into the soil, are critical to reducing exposure and, as a result, the risk of GHG release into the atmosphere. Following that, the incorporated manure will contribute to the carbon sequestration process

Manure collection

- The dung pat/fresh manure is swept or collected in solid form from the walking area and stored directly in the pit or collection point
- When water is used, the manure is swept off as slurry and directed into a covered manure pit. Wherever manure is piled, it should be covered or kept in the shade.

6.3 CLIMATE ADAPTATION PRACTICES

If crops are grown on the farm for feeding to dairy animals, the following practices should be followed:

a) Minimal tillage, which is distinguished by minimal soil disturbance. Tillage avoidance reduces the occurrence of net CO_2 loss due to microbial respiration and oxidation of soil organic matter while also building soil structure and biopores via soil biota and roots.

b) Mulching, in which crop residuals are left to provide protective cover to the soil, helps suppress weeds, reduces soil moisture loss through evaporation, keeps the soil cooler and thus protects crops from extreme temperatures, shields the soil surface from strong winds and rain, reducing soil erosion and flooding risks. Mulch aids in the infiltration of rainwater and the deeper rooting of crops. It also serves as a substrate for soil-dwelling microorganisms, which aids in the improvement and preservation of water and nutrients in the soil. This contributes to the net increase in soil organic matter derived from CO_2 captured by photosynthesis in plants, the residues of which are then transformed and sequestered by soil biota above and below the soil surface.

c) Cover crops can be used to suppress weeds and help cropland retain soil fertility and moisture. They aid in improving soil fertility, allowing farmers to reduce the amount of inorganic fertiliser required for crop production. During the fallow period, they protect the soil from the effects of rain and the scorching sun. They aid in nutrient mobilization and recycling, particularly phosphorus and potassium. Cover crops absorb CO_2 from the atmosphere and thus help to fix carbon in the soil, making the ground a carbon sink that aids in the realise of global warming.

The adaptation and mitigation options for climate change discussed below have implications for natural resource management. The proposed interventions primarily involve strategies to reduce livestock numbers by increasing productivity, as well as land use changes such as incorporating agroforestry and conservation agriculture practices into the farming system.

7 DAIRY COWS GRAZING MANAGEMENT / PASTURES

Certain types of pastures, when properly grown, can provide the cheapest form of dry matter for dairy cows. Pastures that are well-managed can provide cost-effective protein and energy for both maintenance and production. It is necessary to plant pasture species that will grow well all year, providing sufficient herbage for the cows during the summer, and to plant a variety of species to provide for the winter months.

7.1 PASTURE SPECIES AND MIXTURES

The following pastures are the most popular for forage production during the summer months:

- Kikuyu (*Pennisetum clandestinum*)
- Coast cross II, also called K11 (*Cynodon* species)
- Perennial ryegrass (*Lolium perenne*) in cooler areas
- Tall fescue (*Festuca arundinacea*)
- Kikuyu with red and white clover
- Coast cross II with red and white clover
- Perennial ryegrass with red and white clover
- Tall fescue with red and white clover
- Red clover in pure stand
- White clover in pure stand

The following pastures are the most popular for dairy farming in the spring, autumn, and winter seasons:

- Italian ryegrass (*Lolium multiflorum*)
- Perennial ryegrass (*Lolium perenne*)
- Italian ryegrass with red and white clover
- Perennial ryegrass with red and white clover

Figure 14 Pasture for dairy cows.

Summer period

Without the use of concentrate feed, well-managed kikuyu grass could provide for a cow producing 14 to 16 litres of milk per day. Cows producing more than 16 litres of milk per day should be fed energy and protein in the form of a concentrate. In this case, however, it is critical that the dairy cow has access to enough well-managed kikuyu grass for both day and night grazing (see Figure 15).

Winter period

The protein and energy content of well-managed Italian ryegrass/clover is sufficient for a Friesland cow to produce at least 18 litres of milk per day. Cows producing between 18 and 25 litres of milk per day should be given energy in the form of concentrate. It is critical, however, that the intake of the ryegrass/clover pasture be unrestricted (i.e. there must always be sufficient pastures available to the cow).

Figure 15 Dairy cows on pasture.

EXAMPLE: The following Friesland dairy herd module is assumed when calculating the pasture area required for 120 cows in milk, plus their followers:

Class of animal	Animal units requiring pasture*
120 cows in milk	120
30 cows, dry	30
30 x 2 yr old heifers	30
30 x 1 yr old heifers	15
30 female calves	0
TOTAL 240	195

* A mature Friesland cow is assumed heavier than 500 kg live mass.

7.2 PASTURE SYSTEMS

This section of the training manual will review some pasture forage systems that can be used in grazing management.

Having paddocks separated with fences ensures easy management concerning overgrazing. Ensure enough water at all times, animals wont optimally graze if they do not have access to good quality water, placing a water through between two fenced paddocks can assist to reduce costs.

Possible pasture forage systems for the 120 cows in milk dairy module:

SYSTEM 1
150 ha of irrigated perennial ryegrass/clover 20 ha of dryland kikuyu
20 ha of dryland tall fescue/clover
20 ha of dryland tall fescue/clover for foggage
20 ha of dryland kikuyu for foggage

SYSTEM 2
60 ha of irrigated Italian ryegrass/clover 38 ha of dryland kikuyu
20 ha of dryland tall fescue/clover 22 ha of dryland kikuyu for foggage

This system is suitable for the very cold, frosty areas of KwaZulu-Natal (e.g. Bioclimatic Group 4, and parts of 3 and 6).

SYSTEM 3
50 ha of irrigated Italian ryegrass/clover 38 ha of dryland kikuyu
20 ha of dryland tall fescue/clover 22 ha of dryland kikuyu for foggage

Feeding costs will be minimized by implementing one of the possible pasture forage systems referred to earlier.

8 CLIMATE-SMART PLANTED PASTURE MANAGEMENT PRACTICES

When managing grazing dairy cattle, the following factors must be considered:

- **Agroforestry**: On the farm, trees are planted alongside crops. These are trees that produce or are primarily used for the production of fruit, fodder, or fuel (wood), or that provide other benefits such as reducing runoff or erosion, improving soil fertility, providing shade, or providing medicines. Examples such as *Englerophytum natalense, Ptaeroxylon obliquum and Millettia grandis* depending on the region.
  (Mukolwe, 1999)
- **Adoption of climate-smart forage (drought and heat tolerant forage variety)**: Developed specifically to withstand specific climate-related challenges such as droughts, floods, saline or acidic soils, and pests. Spineless cactus, for example, could be used as fodder because it is drought resistant, but it is also an invasive plant in South Africa. Before considering replacement plants that are invasive to the country or region, thorough research should be conducted.
- **Irrigation**: Covers all irrigation types and systems from both ground and surface water sources.
- **Efficient use of fertiliser**: Optimise the consumption in relation to the needs. Lowering manure application rates can help to reduce emissions while preserving farm productivity. Incorporate eco-friendly fertiliser with a low carbon footprint. Spread fertiliser at the best possible time and with the most advanced technology available.
- **Improved, high-yielding varieties**: Purchasing or breeding varieties to improve and increase yields.
- **Stress tolerant varieties**: Use of varieties adapted to a specific region's climate challenges, such as drought/flood/saline/submergence and pest resistant seeds.
- **Destocking**: Reducing the number of livestock as a deliberate decision, rather than as a result of hardships, to improve resilience and make the herd more manageable.
- **Pasture management**: This includes rotational grazing and reserving paddocks in the event of a drought.

Climate-Smart Agricultural practices may have an expected impact on food security, including milk security. These practices will benefit the animals while also increasing productivity and sustainability. Table 1 contains some examples.

Table 1 Examples of food security, adaptation and mitigation synergies.

Examples of possible climate-smart agricultural practices	Expected impact on food (milk) security	Possible impact on adaptation	Possible impact on mitigation
Improved feeding practices such as - introducing highly digestible forages or treating forage to improve digestibility - making silage	Increased dairy animal productivity and milk production	Increased system resilience and reduced cows vulnerability	GHG emissions in dairy farming can be reduced substantially through improvement of feed quality, animal health and husbandry, more efficient energy use and manure management
Improved genetics and reproduction, and animal health control, as well as general improvements in animal husbandry	Increased nutrient cycling and plant productivity		
	Improved fodder production		
Improved manure management			
More efficient crop and grazing land management such as rotational grazing			Reduced forage and milk losses and reduced emissions per unit of milk consumed

9 RAISING CALVES FROM BIRTH TO WEANING

9.1 NEONATAL DEVELOPMENT

According to research, the uterine environment of dry cows can indirectly affect the calf fetus's growth - reduced placenta size and shorter gestation length can all contribute to a lower birth weight of calves and, as a result, a lower wean weight of calves (Gwazdauskas, 1985). The care of the newborn calf begins with proper dry cow care.

9.2 THE NEW BORN CALF

Environmental stressors affect not only animal welfare and productivity, but also the financial health of dairy operations, and should be considered in husbandry practices. Colostrum is and will always be the most important factor in a newborn calf's health. The standard practice is to ensure that the calf receives enough colostrum as soon as possible after birth. The newborn calf is typically removed from commercial dairy production enterprises either immediately after calving or after three days of life. After birth, the dam should be allowed to clean the calf, and the calf should only be removed after 2 hours.

The calf and the dam will be less stressed if the calf is removed earlier. If the calf is removed prematurely, it is critical to ensure that the dam is milked and colostrum is fed to the newborn within 6 hours of birth. If the calf is left with the dam for three days, it must be observed on a regular basis to ensure that the dam allows the calf to suckle. If the calf is not allowed to suckle, it should be removed from the dam and colostrum administered via bottle and teat.

9.3 HOUSING THE CALF

Proper housing for the new calf comes in second place to ensuring good quality colostrum. The calf should be kept in a warm environment with adequate bedding. Draughts should be avoided in calf houses, but ventilation is essential. In addition to being well-ventilated, the calf house should allow plenty of sunlight to enter.

Calves raised on commercial farms are usually housed individually to prevent disease transmission, but calves can also be housed in groups of about five calves of the same age and size.

Figure 16 Calving, cleaning and housing new born calf.

9.3.1 Critical Temperatures

Thermostasis is the process by which warm-blooded animals maintain a constant body temperature despite changes in environmental temperatures.

Lower Critical Temperatures, also known as cold stress, occur when temperatures fall below the point at which the animal can maintain a constant body temperature.

Higher critical temperatures, also known as heat stress, occur when temperatures rise above the point at which the animal can maintain a constant body temperature (Holt, 2014). Temperatures are influenced by a variety of environmental and internal heat from nutrient metabolism factors.

Age, breed, body weight, thermal insulation, nutrition, time after feeding, behavior, housing, wetness of hair coat, and amount of solar radiation all influence critical temperatures. Critical temperatures should be avoided as much as possible; however, it is important to understand that livestock will compensate for critical temperatures by changing their energy intake, energy loss, or energy stored.

9.3.2 Lower critical temperatures

The young calf has less body insulation and higher body surface and body mass ratios, resulting in lower coping mechanisms than mature animals. Calves are more vulnerable to the effects of cold exposure because their thermal defense and coping mechanisms have not yet fully developed, so it is critical that calves remain in a thermos-neutral range of temperatures above 10°C. As shown in Table 2, critical temperatures decrease with calf age, ranging from 10°C in neonatal calves to 0°C in a one-month-old calf.

9.3.3 Higher critical temperatures

Elevated ambient temperatures are also stressors in livestock, particularly calves, resulting in health problems or reduced growth. Again, housing is critical in reducing these stressors. During periods of high ambient temperatures, metal roof structures, shade, sprinklers, and fans have been used to reduce the thermal load of cattle.

Table 2 Critical temperatures at different ages of the young calf.

Age of the calf	Critical temperature (°C)
Neonatal	10
3 Weeks	8
1 Month	0
3 Months	-14

There are well-documented studies that show that using shade to reduce ambient temperatures yields positive results. Calves kept in hutches exposed to direct sunlight would receive an additional radiant heat load than those kept in shaded areas. The heat load will be significantly reduced if the hutch is placed in a shaded area. Any type of shaded structure would have an effect on lowering the higher critical temperatures and could potentially reduce the heat load by 30-50 percent.

Most commercial dairies prefer to use a calf hutch; these structures are exposed to direct sunlight and will receive an additional radiant heat load than in a shaded environment (Bakony & Jurkovich, 2020)

Increased ambient temperatures during the day will cause solar radiation to heat the outer surface of the calf hutch; calves kept in hutches with additional shading will benefit from lower temperatures, lowering heat stress, and ultimately improving health and growth.

Calves can be grouped together or separately. The industry accepts group housing of approximately five calves of the same age and size.

9.3.4 Alternatives

Another alternative to removing a young calf from the dam is to introduce a Dairy Ranching system. This is a practice where the calf stays with the dam until weaning. Cows are parted from their calves in the evening and milked out in the morning before introducing the calf back to the dam for the duration of the day. These cows are not milked in the evening. It has low production costs with lesser liabilities than intensive milk production systems, which includes relative resilience to rising feed prices.

Figure 17 Calves housed in hutches in direct sunlight opposed to shaded hutches.

10 PEST AND DISEASE MANAGEMENT IN DIARY PRODUCTION

Temperature rises have resulted in the spread of disease vectors to previously inaccessible areas (WHO, 2021). Temperature rises have also resulted in increased heat stress in animals, leading to an increase in metabolic diseases in these animals (Lees et al, 2019). Flooding has also increased, bringing with it an increase in vectors such as mosquitoes, which carry not only animal diseases but also zoonotic diseases. Scientists are constantly looking for ways to combat infectious diseases through prevention rather than treatment, as this is the most cost-effective way of dealing with disease.

Climate-smart pest and disease management has the following potential benefits:

- Decrease in mortality rates
- Decrease in morbidity rates
- An increase in disease reporting
- Increased productivity
- An increase in fertility and milk yield
- An increase in income
- Lowering of greenhouse gas emissions

Climate smart pest and disease management for dairy cattle may be split into three categories: biological vector control, resistant breed development, vaccination programs, and parasite control (CCARDESA, 2019).

10.1 WHERE TO START?

- Look at your target farmers and how they are farming
- What are the problems that they think needs the most attention currently?
- What is their main aim with their farming enterprise?
- How are they looking for signs of disease in their animals?
- How do they keep records of their animals?
- What data do they include in their records?
- How do they choose which animals to keep?
- Which vaccines and veterinary drugs are they using?
- Where are they getting the vaccines?
- What infrastructure is available?
- How much labour is available to the farmers?
- Equipment that the farmer has

What then?
Once you understand how the system works, you can create a plan with the farmers' help based on what they see as their biggest problems and on disease observation and recording.

10.2 HOW TO IDENTIFY A SICK ANIMAL

The only way to tell if an animal is sick is to observe how a healthy animal appears. (FAO, 2021).

Looking from a distance

- The animal should stand straight, with its feet squared and its head held high
- It must be constantly alert and aware of its surroundings
- Animals that separate from the herd and refuse to move are sick
- When walking, animals should distribute their weight evenly across all four legs without arching their backs

Looking at the head

- The eyes must be bright and alert and not have any discharge
- The ears should be checked for presence of ticks and any bad smells must be noted

- The nose and muzzle must be moist and not have coloured discharges coming from it
- The mouth must not have excessive saliva dripping from it. Food falling from the mouth can be a sign of teeth problems
- The incisor teeth should be checked for wearing

Looking at the chest

When a cow is resting in the shade, she should be breathing at a rate of 40-50 breaths per minute. The cow's heart can be felt just behind the elbow on the left side, and the heart rate should not exceed 60-80 beats per minute. A lymph node just in front of the shoulder can be felt if it is enlarged, which is a sign of disease. The coat of the animal can be judged on the chest; short haired breeds must have a smooth and shiny coat.

Looking at the back

The body condition score of an animal can be assessed if looked at from behind and above.

Looking at the Abdomen

The amount of fill (whether or not the animal has eaten) can be seen in the paralumbar fossa (the triangle formed behind the last rib in front of the hind leg). You can also feel if the large stomach is moving or not by placing your and in the paralumbar fossa. When an animal is in pain, it will constantly look and kick at its flank.

Looking at the udder or scrotum

The udder must be checked for signs of mastitis such as heat, swelling, pain and inflammation. The thickness and flakes in the milk, as well as the presence of blood, can all be checked. The scrotum of a male animal should be examined for the same signs of heat, swelling, pain, or inflammation, as well as lumps. This can be caused by Orchitis or chronic testicular atrophy.

Taking the temperature

The temperature of any cattle showing signs of illness should be taken, a normal temperature for a cow can be anywhere between 38.5-39.5°C.

Looking at the dung of animals

In cattle, a normal looking putty consistency should be looked for, dehydration can cause firmer dung, and diarrhea can be a sign of infectious disease, worms, or metabolic diseases like acidosis.

Looking at the urine

Urine should be clear and the animal should not show signs of pain while urinating. In a bull blood could be a sign of prostatitis. Blood in the urine can also be due to disease such as Red water or if severe urinary tract infection exists.

10.3 DISEASE REPORTING

One of the most important functions of the extension officer is to assist in the notification of controlled and notifiable diseases to the authorities, as regulated by the Animal Diseases Act 35 of 1984 and its associated regulations.

Link to the **act**:
https://www.dalrrd.gov.za/Branches/Agricultural-Production-Health-Food-Safety/Animal-Health/importexport/legislation/diseaseact

Link to the **regulations**:
https://www.lawexplorer.co.za/StatutoryDatabase/SubordinateFile/SubordinateFileDownload/5843

Additional diseases with trade implications are also reported to the OIE through the Department of Agriculture, Land Reform and Rural Development (DALRD), as extension officers do not have formal training in these diseases and are not expected to note them.

According to the Animal diseases, Act 35 of 1984 the definitions:

- '**controlled animal disease**' means any animal disease in respect of which any general or particular control measure has been prescribed, and any animal disease which is not indigenous or native to the Republic. Table 2 of the regulations on the act gives a list of controlled diseases.
- '**notifiable animal disease**' an animal disease specified in Annexure 3

Defining the term vector as per the CCARDESA definition: Vectors are insects, birds or other animals that transmit a disease and/or pest from one host to another.

10.3.1 Controlled Animal Diseases

The controlled animal diseases (in terms of the Animal Diseases act, Act 35 of 1984) that pertains to cattle are presented in Table 3.

Table 3 Controlled animal diseases that pertains to cattle.

Disease	Clinical signs	Vector
Anthrax	Sudden death with small amount of un-clotted blood coming out of all openings. Trashing and convulsions, fever.	No
Aujeszky's disease (Pseudorabies)	Intense pruritus (itchiness) causing the animals to scratch and bite at the affected area. Neurological signs will include weakness and bellowing, teeth grinding and irregular heart rates.	No
Bovine contagious pleuropneumonia (CBPP)	Adult cattle show signs of pneumonia, standing with elbows out and having chest pains. Calves will show signs of arthritis.	No
Bovine spongiform encephalopathy (BSE)	Abnormal behaviour, struggling to walk, weight loss. Lastly decumbency.	No
Brucellosis	Abortion, stillborn or weak calves, retained placentas and reduced milk yield. Testicular abscesses. Arthritis in chronic infections	No
Corridor or Buffalo disease (*Theilerlosis*)	Fever, listlessness, enlarged lympnodes, reduced milk yield, discharge from the eyes, difficulty breathing.	*Rhipicephalus appendiculatus* (brown ear tick) and ***R. zambeziensis***
East coast fever	Fever, listlessness, enlarged lympnodes, corneal opacity, nasal discharge, diarrhea, anemia and neurological symptoms	*Rhipicephalus appendiculatus* (brown ear tick) and ***R. zambeziensis***

Foot and mouth disease (FMD)	Blisters in the oral cavity and on the tongue, blisters between the toes and above the hooves and on teats. Hyper salivation.	No
Johne's disease	Chronic diarrhea and weight loss with a normal appetite.	No
Nagana (Trypanosomiasis)	Starts with animal becoming listless, coat becoming roughened, ocular discharge, progressive weakness, animal uninterested in surroundings and death.	Tsetse fly
Rabies	Sudden behavior changes, incoordination, abnormal bellowing, excessive salivation, paralysis of the throat and a sudden stopping of milk production in dairy cattle.	No
Rinderpest (globally eradicated)	Fever, diarrhea, discharges from the eyes and nose, sores in the mouth and death in 10-15 days.	No
Tuberculosis	Persistent cough, diarrhea, weight loss and abdominal pain.	No
Any animal disease or infectious agent that is not known to occur in South Africa.	Usually there is a history of an animal being imported or feed that has been imported or taken from ships in the case of these diseases.	

10.3.2 Notifiable Animal Diseases

Notifiable animal diseases (in terms of the Animal Diseases act, Act 35 of 1984) that pertains to cattle are presented in Table 4.

10.3.3 Other common diseases

Other diseases will vary depending on your location and circumstances. As animals huddle together around scarce food and water resources, drought conditions may result in an increase in plant poisonings and respiratory diseases. Skin diseases will become more common as one's immunity deteriorates.

Verminosis (worms) is also a major issue, and weak animals should be targeted for deworming. There are three types of worms: round worms, flat worms, and tape worms.

Mastitis is one of the most common disease problems in dairy cattle; by improving udder health, you can increase the amount of milk you get per lactation per cow by up to 20%. (Rajala-Schultz, 1999; Nesamvuni, 2012).

Nutritional diseases such as ketosis and rumen acidosis may occur as a result of heat stress, as well as dietary changes caused by the unavailability of normal feed that animals are adapted to due to droughts. (Lees and colleagues, 2019)
It is critical to emphasize the role that subclinical diseases play in the health and production of dairy cattle because most farmers are unaware of the economic impact of these diseases (Vesna 2016).

Animals will suffer more from diseases such as foot rot, mastitis, and eye infections carried by flies during floods and wet conditions. Diseases caused by biting flies will become more common

(Caminade et al, 2019). With the new grass growing, nutritional diseases such as prussic acid poisoning, grass stagers, and fog fever may become more problematic.

10.3.4 Zoonotic diseases

Tuberculosis, Brucellosis, Rabies, Salmonella, Rift Valley fever, Ringworm, and Anthrax are examples of diseases that can be transmitted between animals and humans.

To name a few, raw milk can transmit Bovine Tuberculosis, Brucellosis, Salmonellosis, E.coli, Q-fever, Camphylobacteriosis, and Listeriosis.

If you become ill, please notify your healthcare provider that your job requires you to work with sick animals.

10.3.5 Reporting of diseases by farmers

Make sure farmers understand their responsibility to report any animals that show signs of disease to you as the extension officer or to the animal health technician who will summon a veterinarian. It's also a good idea to try to avoid the stigma that comes with reporting some of these diseases. Keep in mind that farmers will only share information with you if you have a strong relationship with them. According to the Animal Diseases Act, it is also the responsibility of animal owners to report these diseases, and failure to do so is a violation of the law.

Table 4 Notifiable animal diseases that pertains to cattle.

Disease	Clinical signs	Vector
Bovine malignant catarrhal fever (snotsiekte)	Fever, discharge from the eyes and nose, lesions in the oral cavity and on the muzzle, opacity of the corneas, neurological signs like head pressing or circling.	Wildebeest or sheep
Bluetongue	Fever, ulcerative lesions in the oral cavity, ulcerative dermatitis, stiffness, increased salivation, lacrimation.	Cullicoides
Lumpy skin disease	Swollen hard nodules on the skin, lymph nodes are enlarged, the nodules can become ulcerated and get secondary infections, also affects the teats, swelling of the udder and brisket does also develop.	Suspected biting flies, 3 species of hard ticks have been shown to be able to transmit the disease.
Rift valley fever	Nasal discharge, excessive salivation, loss of appetite, weakness and diarrhoea.	Various mosquito species (Aedes, Anopheles, Culex, Eretmapodites, Mansonia, etc.)

10.4 BIOLOGICAL CONTROL OF VECTORS

The diseases that are vector-borne will vary depending on the local environment; for example, heart water is only found in areas where the bont tick is present. Diseases spread by biting flies are most common during the rainy season, when mosquitoes and biting midges are more plentiful.

Some ways to control these diseases include:

- Long fallowing periods are required to ensure that the vector dies before the introduction of new hosts.
- To prevent transmission, fence off areas or herd animals away from other herds..
- Keeping animals stabled or kraaled away from high-risk areas at specific times of day, such as to avoid the bluetongue virus or to keep animals away from swampy areas at dusk to avoid biting midges.
- Getting rid of vector breeding grounds, such as stagnant water where mosquitoes breed.
- Setting up pest traps, such as tsetse fly traps, is one example (CCARDESA, 2019).

10.5 OTHER METHODS OF DISEASE CONTROL

Not all diseases are transmitted by vectors, some other transmission methods include:

- Direct contact between sick animals is prohibited (domestic animals and wildlife).
- The sick animals' excretions
- Personnel, clothing, and equipment
- It is found naturally in soil.
- Housing was not cleaned after sick animals were housed in it.
- Feed and water.

10.5.1 Bio-security

Good bio-security is the key in keeping these diseases out of your herds.

- **Quarantine** all new animals for at least 14 days on your farm.
- **Separate** any sick or dead animal from healthy ones immediately (this includes diseases such as footrot and mastitis).
- Do not allow visitors to your herds.
- When returnin**g to your** farm after a trip, make sure to disinfect your footwear.
- If you lend someone **your equ**ipment or vehicle, make sure to disinfect it.
- Always start with the healthy animals and work your way down to the sick animals.
- If you don't have any sick animals, go from the youngest to the oldest.
- As an extension officer, do not visit multiple farms in the same clothing.
- **Washing your hands** and disinfecting them before milking a cow. Milking out mastitis cows last.
- Placing calves with scours on a washable surface and **disinfecting** the surface after the scours has stopped.
- Preventing calves from suckling on each other (Farmers weekly, 2020)

10.5.2 Selecting of resistant breeds

This is covered in more detail by other sections. In general, indigenous breeds are more resistant to naturally occurring diseases and parasites from that area (Kohler-Rollefson, 2004.). Certain diseases are not endemic to the area though and the belief that indigenous breeds do not need to be vaccinated should be warned against.

The best way to go is to select animals from your herd that are constantly afflicted with a disease condition. Allowing unplanned mating to occur will weaken your herd.

10.5.3 Vaccination campaigns

If vaccination campaigns are conducted by extension officers rather than veterinarians, make certain that any other diseases in the animals are documented and brought to the attention of the veterinarian or animal health technician to assist with treatment and veterinary drugs. Many diseases can be avoided or the severity of symptoms reduced by using commercially available vaccines.

When planning a vaccination campaign ensure:

- Arrangement as to the time is made with the owners of the livestock
- Try to go to the farms rather than gathering the animals from different farms together if they do not graze together already
- Make arrangements as to how much the farmers must pay for the vaccines
- Check the availability of handling facilities
- Check the availability of equipment and storage to make sure the vaccines stay at the correct temperature
- Make sure there are enough trained vaccinators
- Get an approximation of the amount of animals that will need vaccination
- Make sure that enough vaccines are ordered and available to do the campaign.
- Make sure that the time of year to do the vaccination is relevant to the disease and to when the farmers have time
- Ensure that farmers are informed about the vaccine's benefits and the need for revaccination
- Ascertain that a method for identifying vaccinated animals exists
- Make sure there's a way to keep track of the animals that have been vaccinated, as well as receipts for payment from the farmers
- Will the farmers be able to continue receiving these vaccinations?

When giving the vaccine:

- Make sure you know the vaccine's batch number and expiration date
- Ascertain that the cold chain was kept intact
- Only use the vaccine as directed on the package
- If the vaccine label says you can't keep it, don't use it again
- Check the vaccine dose
- Check to see if it's safe to give to pregnant animals
- Look for potential risks to vaccine recipients and make them aware of them
- Vaccinate only healthy animals
- Never guarantee a vaccine's 100 percent success rate to a farmer

The following is an example of a vaccination program from Onderstepoort Biological products: https://www.obpvaccines.co.za/resources/documents/Immune-Program.pdf

This information can be combined with current disease trends in the area to create your own practical vaccination list.

10.5.4 IMMUNISATION FOR CATTLE

10.5.4.1 Animals that have not been immunized before

Initial vaccination should be done in accordance with the farm's management systems and breeding program. The schedule presented in Table 5 can be changed to fit the specific farming conditions.

Table 5 Immunisation schedule for animals that have not been immunized before.

Time of administration	Essential vaccines	Optional vaccines	Dose and route
6-8 weeks before the breeding season	Rift Valley fever (inactivated) RVF (live vaccine) OR Clone 13	-	2 mℓ subcutaneously 1mℓ Subcutaneously
	-	Vibriosis (1st inject.)	2 mℓ subcutaneously (heifers) 5 mℓ subcutaneously (bulls)
3-4 weeks before the breeding season	-	Vibriosis (2nd inject)	2 mℓ subcutaneously (heifers) 5 mℓ subcutaneously (bulls)
8 weeks before calving (heifer)	-	Escherichia coli (1st inject)	2 mℓ subcutaneously
2-4 weeks before calving	-	Escherichia coli (2nd inject)	2 mℓ subcutaneously
7-14 days of age	Paratyphoid (1st inj) (live or inactivated vaccine)	-	5 mℓ subcutaneously (live or inact) 10 mℓ subcutaneously (inact for cows)
	Heartwater blood (endemic areas) (0-21 days of age)	-	3 mℓ intravenously
	-	Pasteurella (1st inject)	5 mℓ subcutaneously
	-	C. *pyogenes* (1st inject)	5 mℓ subcutaneously (< ?? months) 10 mℓ subcutaneously (> ?? months)

3-8 weeks of age	Paratyphoid (2nd inject) (Inactivated vaccine at 3 weeks of age)	-	5 mℓ subcutaneously (live or inact) 10 mℓ subcutaneously (inact for cows)
	-	Pasteurella (2nd inoc.)	5 mℓ subcutaneously
	-	C. *pyogenes* (2nd + 3rd inject)	5 mℓ subcutaneously (< 6 months) 10 mℓ subcutaneously (> 6 months)
4 months of age	Contagious abortion S19 (heifers at 4-8 months)	-	2 mℓ subcutaneously
	**Gall sickness (3-9 months) endemic areas	-	1 mℓ intramuscularly
5-6 months of age or at weaning	Botulism/Blackquarter (1st inject) OR Botulism/Gasgangrene (1st inject) OR Doublesure	-	5 mℓ subcutaneously OR 5 mℓ subcutaneously 2 mℓ subcutaneously
	Anthrax	-	1 mℓ subcutaneously
	-	Redwater (3-9 months) (endemic areas)	1 mℓ intramuscularly
5-6 months of age or at weaning	Rift Valley fever (inactivated vaccine) Clone 13 Rift Valley live	-	2 mℓ subcutaneously 1 mℓ 1 mℓ
	Botulism/Blackquarter (2nd inject) OR Botulism/Gasgangrene (2nd inject) OR Doublesure	-	5 mℓ subcutaneously OR 5 mℓ subcutaneously 2 mℓ subcutaneously
	Lumpy-skin disease	-	5 mℓ subcutaneously
	B. Phemeral (Dairy cattle)	-	2 mℓ subcutaneously

** Gall sickness + Redwater vaccine can be administered together.

10.5.4.2 Sustained immunization programme for adult cattle

Booster injections can be given once a year or six times a year. Table 6 is a practical example that can be changed to fit the local farming conditions.

Table 6 Sustained immunization programme for adult cattle.

Time of administration	Essential vaccines	Optional vaccines	Dose and route
Late winter, Early spring (Aug - Sept)	Three-day stiff sickness	-	2 mℓ
	Lumpy skin disease	-	2mℓ subcutaneously
	Rift Valley fever (Inactivated vaccine) Clone 13 Rift Valley (Live)	-	2 mℓ subcutaneously 1 mℓ 1 mℓ
	-	*C. pyogenes*	10 mℓ subcutaneously (<6 months) & 5 mℓ subcutaneously (>6 months)
	-	Pasteurella	5 mℓ subcutaneously
Autumn or early winter (April - June)	Blackquarter/Botulism OR Gasgangrene	-	5 mℓ subcutaneously OR 5 mℓ subcutaneously
	Anthrax	-	2 mℓ subcutaneously
	Botulism – (if combinations were not used)	-	2 mℓ subcutaneously
	-	C. pyogenes	10 mℓ subcutaneously (>6 months)
	-	Pasteurella	5 mℓ subcutaneously
± 4 weeks before breeding	-	Vibriosis	2 mℓ subcutaneously (heifers) 5 mℓ subcutaneously (bulls)
2-4 weeks before calving	-	Escherichia coli	2 mℓ subcutaneously

10.5.5 Endo- and ectoparasite control

Although selecting a resistant animal is still the best option, using endoparasites at specific times of the year will benefit the animal and help it produce more. When using a product, check to see if:

- It covers the parasite you wish to control.
- It has not expired.
- The dosage at which you should be giving it.
- IF it is safe to use for e.g. in lactating dairy cows.
- The milk and meat withdrawal times.

Acaricides should only be used if ticks are found on the animals. Avoid causing product resistance by using the product incorrectly. In South Africa, where Acaricide resistance is widespread, selecting for animals with greater tick resistance is a better economic and environmental option.

10.6 CHOOSING A SOLUTION FOR YOUR AREA

A combination of all three of the methods listed above is frequently required to be successful in controlling diseases and pests in your area. None of the methods will work unless you have the backing of your local farmers. To obtain this support, a significant amount of education and trust-building will be required. Farmers must buy into the program and make it their own in order for it to work.

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For additional resources see:
https://www.dalrrd.gov.za/Resource-Centre?folderId=147&view=gridview&pageSize=10

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