These guidelines have been developed for use by the extension specialists of the Rural Development Agency and by private extension specialists. Extension specialists work through the Ministry of Environmental Protection and Agriculture Information Consultation Centres (ICC's) which are based in municipal and regional centres. They invite local farmers to in-field and office training.


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# Contents

# Executive Summary

These guidelines have been developed for use by extension specialists to teach livestock farmers of dairy and meat cows how to mitigate the negative impact of climate change on their livestock production. Climate change is the key issue of our time and is causing extreme weather events and unpredictable weather patterns, all of which are having a drastic impact on livestock production and livelihoods based on natural resources.

In Georgia, 51% of the population depends on livestock for their livelihoods. Cattle in particular, primarily for dairy and meat, are a main form of food security and income for households across all agri ecological zones of Georgia. Women often control the income brought into the household through the sale of milk and dairy products and spend that income on improving family circumstances including spending on education and health as well as on labour saving devices. Therefore, countering the negative effects of climate change on livestock production and providing livestock farmers with the tools to mitigate these negative effects and adapt to them, is vitally important for rural society across Georgia.

These guidelines comprise of three comprehensive chapters, each providing practical recommendations vital for equipping farmers with the means of understanding and addressing the negative impacts of climate change on aspects of their livestock production. Two Annexes on Harmful Gas Accumulation and Diseases contain technical detail. Throughout the training the guidelines will be used in conjunction with ancillary training materials detailing the techniques described in this manual.

**Chapter 1:** Focuses on general husbandry practices related to extremes of heat and cold. It details the symptoms and effects of heat and cold stress on livestock. Emphasis is placed on mechanisms to be used on pasture and within livestock housing to counteract environmental stresses.

**Chapter 2:** Delves into diseases influenced by climate change, with a particular focus on temperature related illness and disease, vector borne diseases, digestive dysfunctions and respiratory issues. It underscores the importance of good management and preventive measures to safeguard livestock health in the face of increasing climate related challenges.

**Chapter 3:** Focuses ways to enhance animal feed quality from farmed plots in the face of the climate influenced effects and damage of drought, wind and soil erosion and extreme weather events such as flooding and storms. Methods include enhancing soil water retention, minimal cultivation, windbreaks, mulching, using appropriate varieties, appropriate sowing practices, considered fertilizer use and crop rotation.

# Inclusion

Climate change affects everyone, regardless of their demographic or geographical location. However, it disproportionately affects marginalized people with fewer resources and less power. Marginalized people are often more concentrated on marginalized land with poorer soil, steeper slopes or limited access to water. Marginalized people often have limited access to resources and are unable to access or afford alternatives such as bought in feed when local grazing or crops fail in a drought. They do not have the option to move or change location when production challenges mount. They cannot or do not know how to access knowledge or finances to adapt to the effects of climate change and cannot or do not feel the agency or legitimacy to engage with local decision-making concerning issues or resources.

Trainings must therefore reflect the social, economic and environmental factors affecting the perspectives and needs of cattle farmers in each locality. This means understanding the factors which impede or change

the level of access or needs of the rural population who the extension is trying to reach. These factors are diverse and include gender, ethnicity, age, wealth, religion, geographic location (ranging from lowland to upland areas) and farms of varying size and type of productivity (be they small, medium, or large, or a household operation mainly providing food security, income from sales of surplus or semi or fully commercial). All these factors affect the extent to which people can access resources, including information, networks, inputs and finance, or feel able to access public goods or input into or influence household, community or local decision making.

Extension specialists play a pivotal role in ensuring inclusion throughout the training process. This entails implementing the following:

**Inclusive invitations**: Trainee selection should ensure a true representation of all producers in each locality. Invitations to individuals from diverse backgrounds, ensuring representation across genders, ethnicities, and socio-economic layers, agro ecological zones and farms of different sizes should be a prerequisite. Ensuring the inclusion of smaller producers, household enterprises, which ensure household food security, is essential. Trusted community figures can be engaged to ensure participation in harder to reach areas.

**Language access:** Training sessions and materials should be conducted and available in first languages that ensure the comprehension and full participation of Azerbaijani and Armenian farmers.

**Tailor training to ensure inclusion:** The training **e**nvironment should be acceptable and safe from each participant's cultural perspective. Trainings should be held in locations accessible to participants from different geographical areas. Training times and dates should be scheduled to be convenient for all; take into consideration when people are most busy during the day or season or unavailable (e.g. call to prayer, Ramadan, milking, working in the field, harvest time, planting time, looking after children, elderly dependents, working in other jobs).

# Introduction

These guidelines are tailored for extension specialists aiming to equip livestock farmers with effective strategies to navigate the challenges posed by climate change. Trainers will utilize detailed ancillary training materials throughout the training in conjunction with the guidelines to enlarge upon and explain the techniques, models or technical areas described in the manual.

Undesirable consequences caused by changes in the environment severely affect animal production. Farmers find themselves on the frontline in dealing with the adverse effects of climate change on their production. The normal challenges farmers face in livestock production are exacerbated by climate changes. Extreme and unpredictable weather events, violent temperature fluctuation, land degradation, and reduced water resources have a direct impact on livestock. These impacts include temperature stress, poorer quality feed, reduced nutrient availability and increased incidence of emerging diseases. This causes decreased intake, appetite, and digestive efficiency and weakened immune systems, which makes animals more susceptible to parasitic infestation and other infections for example mastitis, often leading to increased use of antibiotics. A decrease in the productivity of the animals and reduced income is the result.

Livestock farmers follow practices established for years, which have little results in the face of these new challenges. They are willing to adopt new practices, if provided with relevant and information applicable to them and their situation. There is a lack of awareness and confusion among farmers about sustainable production practices, either due to lack of information, inadequate guidance, or financial limitations. The current situation however is forcing extension specialists and farmers to find and adopt practical and affordable production methods to help farm more sustainably. Empowering livestock farmers with insights on managing temperature stress and diseases, fortifying animal immune systems, nurturing soil and pastures and boosting productivity, charts a course towards sustainable farming practices that are able to mitigate the negative effects of climate change and lead to safeguarded and more sustainable productivity and better animal, environmental and human welfare.

The need for effective communication between extension specialists and farmers is paramount. To foster this alliance, the present guide has been developed for the Rural Development Agency's extension specialists and their private counterparts. It serves as a roadmap, to guide them through the communication of climate-resilient, sustainable farming practices designed to practically address the issues relevant to the female and male farmers that they serve in communities across Georgia.

# Chapter 1
# General Husbandry

Chapter 1 aims to develop a more comprehensive understanding of the effects of heat and cold stress on livestock, its management and to convey practical methods of ensuring the well-being of livestock in challenging environmental conditions.

Climate change is leading to more prolonged and extreme heat and drought, sudden drops in temperature and extreme cold, considerably increasing environmental stress on livestock. Heat and cold stress are induced by extreme weather conditions. Balanced climate conditions are vital for successful animal production. Large increases or decreases in temperature and humidity have a negative impact on animal health and subsequent productivity. Appropriate shelter, housing, watering, feeding and hygiene play a vital role in mitigating the risks caused by temperature stress.

At the end of this chapter, training participants will be able understand the heightened risks to the animal of heat and cold stress, identify the negative effects of rising or decreasing temperatures and humidity on livestock production and the symptoms of this stress. They will understand how to adapt their husbandry practices to mitigate and counter these effects on their livestock production.

## Learning objectives

Participants will:

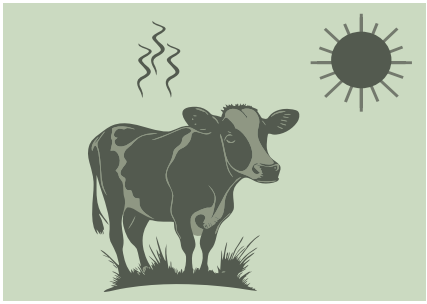
- Understand the link between climate change and livestock health in relation to extreme temperatures.
- Recognize the signs and symptoms of heat stress in cattle, its impact on health and productivity and learn mitigation strategies to deal with it: including shelter, ventilation, and balanced feeding practices.
- Describe the challenges posed by extreme heat on pasture management and water supply for livestock.
- Recognize the signs and symptoms of cold stress in cattle, its impact on health and productivity and learn how to mitigate cold stress, including providing shelter, access to clean water, and adjusting feeding practices.
- Understand the importance of managing the cowshed microclimate for animal health and well-being, including hygiene, ventilation, and harmful gas accumulation.

# Extremes of Temperature

Extreme temperature is hotter temperatures for prolonged periods of time including at night and extremes of cold often at unpredictable times of year. Extreme temperatures, whether hot or cold, have various impacts on the environment and animal welfare. Climate change is contributing to an increase in the frequency and intensity of extreme temperature events, leading to more frequent and severe heatwaves, droughts, and cold spells in different parts of Georgia. These extremes have significant implications for animal well-being, water resources and infrastructure.

## Heat Stress

High humidity and temperatures compromise the body's ability to release enough heat from the body to cool down and can result in heat stress. Excessive exposure to the sun can also cause sun stroke in cattle. Different breeds have varying tolerances to heat, and factors such as age, health status, and acclimatization also influence their susceptibility to heat stress. The more productive and larger the animal is, the less it can withstand high temperatures. In Georgia, where temperatures can frequently exceed optimal ranges for cattle production over 26 $^{0}$C, managing heat stress becomes a critical aspect of dairy farming. Farmers may employ various strategies to mitigate the effects of heat stress, including providing shade, ensuring proper ventilation in cowsheds, and adjusting watering and feeding practices to account for reduced appetite during periods of heat stress.



**When excessively hot animals may:**

- Seek shade
- Group near a water source
- Need more water

**Signs of Heat Stress:**

- Sweating
- Panting, open mouth breathing
- Listlessness, exhaustion
- Reduced appetite
  Excessive salivation

**Impacts of Heat Stress:**

- Overheating (inability to cool down)
- Dehydration (lack of water in the body) which can lead to heat exhaustion.
- Heatstroke and sunstroke (see Chapter 2 Illness and Disease for details)

**Over time excessive heat can lead to:**

- Exacerbated digestive, cardiovascular, and respiratory problems.
- Reduced milk yield
- Reduced weight gain
- Reduced fertility
- Reduced immunity
- Increased incidence of illness and disease e.g. mastitis, parasitic infection (see Chapter 2)

**Combatting Heat Stress**

The main means of combatting the development of heat stress in cattle is reducing exposure to direct sunlight, providing shelter and shade including when at pasture (see below), reducing ambient temperatures in housing and providing access to water.

**Recommendations:**

- Provide access to shelter on open pasture.
- Improve ventilation in cowsheds.
- Roof farms with light-colored material to reflect radiation.
- Ensure clean, soft and dry bedding.
- Ensure that animals have unlimited access to clean water.
- Adjust balanced feeding practices to enhance appetite and ensure proper rumen function.

**Heat Stress on Pasture**

Helping animals cope with high temperatures on pastures where animals spend time under the sun poses significant challenges. There is often a shortage of water on pastures, preventing livestock from accessing the necessary volume of water in a timely manner. Additionally, water on pastures tends to be of high temperature and polluted. Cattle require an adequate water supply to maintain their health and productivity. The warmer the weather and the higher the milk production of a cow, the greater the amount of drinking water required. Ideally in livestock production water should be provided ad libitum, meaning that the animal has access to as much water as they require. Animals living in dry climates with higher ambient temperatures and consuming larger amounts of dry feed with low moisture content will also need more water.

**Recommendations:**

- Using the shade of trees to provide shelter for cattle.
- Planting fast-growing trees on pastures to establish long-term natural shade. When selecting tree species, it's essential to consider the specific climate, soil conditions and intended purpose to ensure successful growth.

**BOX 1: Basic Shelter**

To set up a basic livestock shade, wooden or iron poles pinned in the ground can be used as a framework. Straw, thick fabric, canvas, as well as any sturdy roofing material are suitable for creating the roof.

If there is no natural shade available, it is recommended to set up a simple shed or basic shelter. Box 1 provides an example. Figure 1 provides illustrations.

- When it is hot and humid, grazing during the night is an option.
- Improve pasture water supply. Box 2 provides an example. Figure 2 provides an illustration.
- Get local support: addressing water access for pastures and providing shading can be deliberated during village meetings, where public officials seek ideas on how to allocate the village budget.

BOX 2: How to Improve Water Supply

When natural water sources are scarce, the collection of rainwater becomes crucial accomplished through ponds, tanks, or reservoirs. One option is installing water points connected to water tanks, periodically refilled by water-carrying cisterns. Another possibility is to establish a communal well on the pasture, serving multiple farmers or villages in the area.

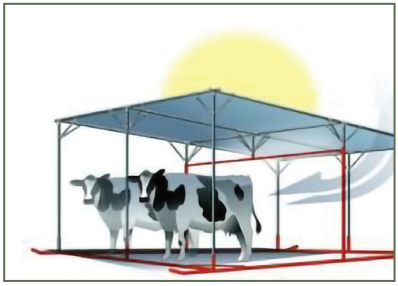


*Figure 1 Illustrations of Basic Pasture Shelter*

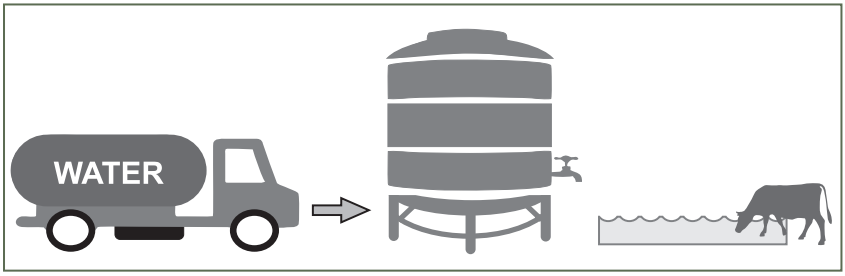



*Figure 2 Illustration of Water Points Connected to Water Tanks, Periodically Refilled by Water-Carrying Trucks*

# Cold Stress

Cold stress in animals occurs when environmental conditions, particularly low temperatures, exceed the comfort zone for a specific species. Cold temperatures provoke a decrease of leukocytes in the blood and phagocytic activity. When there's a decrease in the number of leukocytes and their phagocytic activity, the body's ability to fight infections is compromised. This makes cattle more susceptible to illnesses and infections, as their immune system is weakened. If the temperature drops below +5 degrees, the risks of cold stress and illness increase, the cattle lose the ability to control their body temperature, leading to cold stress. It may also occur at higher temperatures (up to +15 $^{0}$C), if coats are wet, making it harder for cattle to stay warm. Different breeds have varying tolerances to cold, and factors such as age, breed, health status, and acclimatization can influence their susceptibility to cold stress. Colder temperatures require that the animal use more energy to stay warm, a sufficient ration is therefore also necessary to aid the animals to cope. The severity of cold stress depends on the duration and intensity of exposure. Animals respond to cold stress through physiological mechanisms aimed at maintaining body temperature. These responses may include shivering, increased metabolic rate, and changes in blood flow to conserve heat.

**When excessively cold animals may:**

- Seek shelter
- Stand by windshield in group
- Huddle in a group

**Signs of cold stress:**

- Shivering
- Increased heart rate
- Reduced grazing
- Decreased demand for water
- Coarsening of the coat

**Impact of cold stress on cattle:**

- Disruption of metabolism
- Slowed digestion
- Weight loss
- Compromised immune function
- Reduced milk yield
- Increased risk of freezing in calves
- Susceptibility to diseases, and, in extreme cases, hypothermia or frostbite (see Chapter 2)
- Underdevelopment of the fetus

**Recommendations:**

- Provide shelter
- Protect animals from drafts whilst allowing for adequate ventilation.
- Provide access to clean, soft and dry bedding.
- Ensuring that animals have unlimited access to unfrozen and clean water is critical during cold periods. Dehydration can occur if water sources are unavailable or if animals are unwilling to drink extremely cold water.
- Adjusting/increasing feeding to provide a balanced and high-energy ration to meet increased energy requirements during cold weather is an essential measure.
- Provide mineral salts.

# Cowshed Microclimate

Good management of the cowshed microclimate provides the opportunity to provide relief from heat or protection from cold. Caring for the health and well-being of the animal begins with the conditions in the cowshed. Within the cowshed, important considerations include hygiene, ventilation, and the accumulation of harmful gases.

In hot weather, high temperature and humidity create favorable conditions for the reproduction of microbes, playing an important role in increasing the probability of and speeding up the spread of infectious diseases. High temperatures also speed up the decomposition of manure, leading to the production of ammonia and hydrogen sulfide, which can negatively affect the air quality in a confined space. High concentrations of these gases are mainly found on farms with manure pits, deep litter, and warm cowsheds. This issue also persists in winter when manure remains in the cowshed for extended periods.

**Cool Sheds:** In recent years, especially when winters are not as harsh and animals experience optimal ambient temperatures, the practice of cool farms has been introduced. This involves keeping animals in open spaces throughout the year rather than in closed sheds. In cool farms animals require shelter to protect them from drafts in winter and the sun in summer. Even calves on these farms can tolerate air temperatures below 0°C if dry, wind-protected microclimatic zones are created for them with straw bedding.

## Hygiene

Good hygiene is a vital tool in helping them cope with environmental stress. When animals are kept in unhygienic conditions it leads to the accelerated accumulation of insects and microbes, weakening natural defense mechanisms, and making animals more susceptible to disease. Dirty hair loses its insulating and protective function. Manure splashes onto the cattle as they walk, and any dirt on their feet will eventually end up in the bedding area. Additionally, manure may be transferred

from the dirty hind legs of cows to the udder while lying down, making it dirty too. A wet and dirty walking area also decreases the durability of the hoof cornea and increases the risk of hoof and limb diseases.

**Recommendations:**

- Regular cleaning and manure removal
- Adequate ventilation
- Adequate drainage
- Clean and dry bedding
- Implementing pest control measures to prevent the infestation of flies, rodents, and other pests. Use approved insecticides and rodenticides as needed.

## Ventilation

Dust, the smell of ammonia, and cobwebs in the cowshed are signs of insufficient ventilation. A cowshed should be designed to provide animals with adequate air exchange and ventilation, even on windless days. Ventilation should ensure the removal of excess heat, water vapor and moisture, as well as microorganisms, dust, and gases. It is necessary to ensure the correct flow and equal distribution of air in the building.

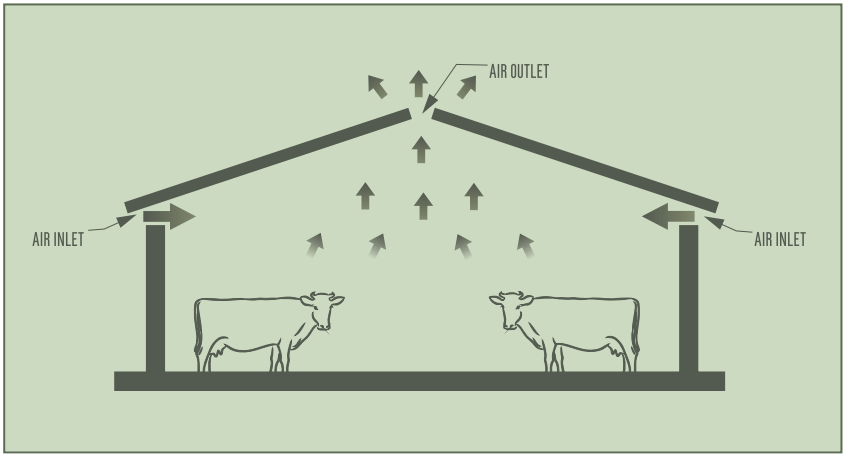



***Figure 3 Demonstrating Air Flow in Cattle Housing***

The heat from cattle rises naturally, and if it does not have a way to escape through a vent in the ceiling, it condenses, increasing humidity in the shed. As the air cools, moisture falls back into the bedding, creating a favorable environment for the growth of microorganisms. Cattle housing should have a roof vent and air inlets at the side. This will allow a stream of fresh air to flow into the building from the side walls, however the airflow area should be sufficient to create the air stream. *See Figure 3 below.*

**Recommendations:**

- During high temperatures, natural ventilation helps cool the livestock through air exchange.
- In summer, wind primarily drives natural ventilation (air exchange).
- In winter, air exchange is mainly facilitated by heat buoyancy forces, known as the 'chimney effect'. The chimney effect can enhance natural ventilation within a building, helping to maintain comfortable temperatures and air quality as long as warm air rises and exits through upper openings while cooler air is drawn in from outside at lower levels, facilitating the chimney effect and natural ventilation as in shown in Figure 3.
- However, the chimney effect doesn't work in summer when the air temperature inside and outside the cowshed is almost the same, so additional ventilation is required such as opening doors to increase airflow.
- Use a roof design that allows hot air to rise and escape, for example a ridge vent or a raised central portion of the roof.
- Consider using reflective roofing materials to reduce heat absorption.
- Consider investing in insulation particularly in the roof. Insultation helps keep buildings cooler in hot temperatures and warmer in cold temperatures.

## Harmful Gas Accumulation

The accumulation of harmful gases in inadequately ventilated cattle housing has a deleterious effect on the overall well-being of cattle and reduces their ability to cope with the effects of heat and cold stress.

The main harmful gases in cowsheds are:

- Carbon dioxide
- Hydrogen sulfide
- Ammonia
- Carbon monoxide
- Methane

These gases are commonly found in livestock farms, and the presence of two, three or more harmful gases can affect the animals. Under their influence, a number of pathological changes take place in the animals, which reduce the resistance of their organs and are predisposing factors for disease.

**Recommendation:**

Ventilation is the most important measure to reduce the accumulation and prevent a high concentration of harmful gases in the cowshed.

For further details on harmful gas accumulation, please refer to Annex 1

# Chapter 2
# Illness and Disease

Chapter 2 delves into the amplified incidence of diseases resulting from evolving climate patterns. The changing climate significantly impacts environmental factors which ultimately exacerbates temperature related conditions and respiratory, digestive and vector borne diseases.

Increased early temperatures and mild winters foster favorable environments for the proliferation of both internal and external parasites such as ticks, increasing the incidence of vector borne diseases. Sudden or unseasonal temperature drops also compromise animals' immune systems, rendering them more vulnerable to respiratory infections. Climate stresses can alter the nutritional composition, quality, and production of animal feed leading to increased incidence of digestive diseases. During droughts, stressed plants undergo alterations in composition, losing essential nutrients while toxic plants thrive affecting the quality of grazing and hay.

The prevalence of these diseases and their exacerbation due to climate changes necessitates farmers' comprehensive understanding and adeptness in handling them. Proactive management practices and appropriate veterinary care remain pivotal in ensuring the welfare of animals grappling with these environmental challenges. Detailed descriptions of diseases and their link to climate change are provided in Annex 2. Table 1 provides a summary of these diseases, their link to climate change and their management.

At the end of this chapter including study of Annex 2, training participants will recognize the correlation between climate change and disease incidence, including conditions caused by excessive heat and cold, digestive conditions linked to changes in feed and feed regimens brought about by climatic conditions and the increased incidence of parasites and vector-borne diseases. This knowledge will assist farmers in adapting their husbandry practices to mitigate these effects on livestock production.

### Learning objectives

Participants will:

- Recognize common weather-related illnesses in cattle, including heatstroke, sunstroke, and frostbite and identify appropriate treatment and prevention measures.
- Understand the impact of weather extremes on health, identify symptoms and comprehend treatment practices for digestive diseases in cattle, vector-borne and respiratory diseases.
- Be capable of adapting husbandry practices to mitigate and counter these effects on their livestock production.
- Gain knowledge about the role of prebiotics and probiotics in maintaining immune systems, productivity and treatment.

# Illness Linked to Temperature Extremes

Temperature extremes can have a significant impact on health, causing various illnesses such as heatstroke, sunstroke and frostbite and contributing to others such as mastitis. Farmers must take measures to ensure the well-being of cows. This includes providing appropriate shelter and addressing any specific challenges posed by the local climate.

## Heatstroke and Sunstroke

Heatstroke typically occurs when a high temperature and humidity occur at the same time. Overexposure to the sun without means of cooling may also cause heatstroke. A high temperature and high humidity make it harder for animals to release excess heat into the environment. Heat accumulates in the body and leads to overheating. The only way to release excess heat from the body is to sweat, but this process is inhibited by high humidity. Over-crowding of animals, excessive humidity

and insufficient ventilation in the cowshed may also be factors contributing to heatstroke. Temperature alone is not a good way of measuring heat stress. A Temperature Humidity Index (THI) takes into account ambient temperature, relative humidity and evaporation rate.

Sunstroke is caused by overexposure to the sun's rays on the animal's head and body. Direct sunlight causes hyperemia (increased blood flow) and swelling of blood vessels in the brain. Intracranial pressure increases and can lead to paralysis of the center of respiration and blood vessels and possibly to the death of the animal.

**Symptoms:**

- Excessive panting
- Increased respiratory rate
- Drooling and slobbering
- Increased heart rate
- Lethargy or weakness
- Reduced feed intake
- Dehydration
- Decreased milk production
- Severe cases of heat stress lead to neurological symptoms, including a lack of coordination or staggering. In extreme cases, cattle may collapse or be unable to stand.

**Treatment:**

- Provide proper shade.
- Ensure adequate ventilation.
- Provide cool water.
- Apply ice wrapped in a bandage.
- Avoid strenuous activities during the hottest parts of the day.
- In severe cases, use methods like spraying affected animals with water or using fans to enhance cooling.

# Frostbite

Frostbite is the long-term effect of low atmospheric pressure cold air on the skin and deep soft tissues where water in the organs and tissues freezes and turns into ice resulting in inflammation and necrosis in the affected areas. Frostbite in animals often takes place in a damp cowshed, which is not protected from wind and where the effect of low temperature is particularly strong. Frostbite develops first in the places which are not covered by hair, especially the udder, ears, seminal vesicles, and tail.

**Symptoms:**

- Cattle may exhibit signs of numbness or reduced sensation in frostbitten areas.
- Swelling: the affected areas, for example the ears, tail, udder, or extremities, may show swelling.
- The skin may change color, becoming pale or bluish, and in severe cases, it may appear black due to tissue damage.
- The skin on the affected areas may crack or peel.
- The frostbitten tissue may feel hard or firm.
- In the early stages, cattle may show signs of discomfort or pain in the affected areas.

**Treatment:**

- Move the animal to a warm cowshed and the frozen areas should be warmed up.
- Protect the animal from frost and drafts.
- Use of warm baths is recommended with dry stubble/straw for the animal to lie on underneath.
- Antiseptic can be used on damaged areas.
- Strengthen immunity by adding biological supplements (prebiotic and/or probiotic) to the feed ration.
- Antibiotics should only be used in extreme cases.

# Mastitis

Mastitis is the most common disease affecting milking cows in Georgia, it is an infection of the mammary gland. Environmental mastitis is caused by pathogens present in external sources such as dirty bedding and standing water. Contagious mastitis is spread between cows through milking equipment or by the hand milker. The teat canal is open for up to thirty minutes following milking and infection commonly occurs through contact with pathogens at this time. Mastitis can be clinical in which symptoms are clearly apparent, such as a red swollen udder and abnormal colour, texture or odor of milk, or sub -clinical, identified by a high Somatic Cell Count (SCC) in the milk. Visual inspection of the udder, teats and milk can help identify mastitis, as well as use of a rapid mastitis test where a reagent is added to milk, and the subsequent reaction indicates the level of infection.

Heat stress depletes the resilience of animals and their resistance to disease. High temperatures significantly disrupt the functioning of neutrophils, which play a central role in protecting the udder from infection, mastitis therefore most frequently occurs within the hot period of the year. When humidity is high in the cowshed, there is a higher risk of deleterious microorganisms appearing, therefore in higher temperatures, correct milking is important for the health of the cow and to maintain the quality of milk. Thermal stress also negatively affects the composition of milk fat and protein, increasing the risk of developing mastitis.

**Diagnosis and Treatment:**

- *Visual inspection for mastitis detection*. Look for signs of inflammation, swelling, redness, or heat on the udder. Check teats for damage like cracks or sores. Normal milk flow should be consistent from all teats. Irregularities like reduced flow, clots, or abnormal color indicate mastitis.
- *Foremilking and the California Mastitis Test (CMT)* aim to detect mastitis early. Foremilking involves manually stripping milk into a dark vessel, where clots or color changes indicate mastitis. The

CMT is a simple test using a reagent to detect subclinical mastitis by observing changes in milk viscosity once mixed with the reagent.

- *Maintaining teat hygiene:* Disinfection should occur before and after milking and a product which creates a barrier film to shield the teat from further damage can be applied.
- *Further treatment* should be carried out under the supervision of a veterinarian who can confirm the diagnosis and administer antibiotic treatment.

**Management:**

Proactive strategies to avoid mastitis are the best management strategy. A good milking routine paying scrupulous attention to hygiene is essential. Consistent milking helps maintain udder health by preventing overfilling of the udder, which can lead to pressure-related damage and increased susceptibility to mastitis. The correct use of milking machines can help prevent mastitis. Proper attachment and detachment of the milking units, appropriate vacuum levels, and gentle handling of the udder can help prevent injuries and reduce the risk of mastitis. Milking machines provide a consistent and efficient way of extracting milk from the udder. However milking machines should be cleaned and sanitized regularly to prevent bacterial contamination. In addition:

- *Disinfect teats before and after milking:* Apply a pre-milking udder dip or spray. Alternatively, apply a herbal udder foam that moisturizes and soothes the udder and teats. Use clean equipment for each cow.
- *Reduce pathogen transmission opportunities post milking:* Mastitis can easily occur after milking because the teat canals remain open for up to 30 minutes and if the animal lies in contact with dung and urine, bacteria can enter the canal and cause infection. Ensuring that cows have clean, dry bedding reduces the risk of transmission and infection. Providing feed post milking will keep cows standing and reduce transmission risks while the teat canal is open.

- *Follow a milking order to reduce transmission:* milk young and healthy cows, followed by cows with mastitis. Cows taking antibiotics should be milked separately and the milk disposed of separately.

***Figure 4 Testing for Mastitis (California Test)***

# Respiratory Illness

Respiratory illness is linked to cold and damp weather, prolonged, severe or unseasonal cold and rainy spells will exacerbate respiratory conditions. Poor ventilation, harmful gas accumulation, moldy feed and spores, unhygienic cowsheds and microorganisms are also contributing factors. Animals typically fall ill in early spring and late autumn while on pasture during cold, rainy weather.

**Annex 2 describes Bronchitis and Bronchopneumonia in detail.**

# Illness Linked to Climate Affected Diet

Although climate change does not directly cause digestive disturbances, it indirectly affects livestock health by contributing to the development of environmental conditions that influence feed content, quality, availability, and grazing patterns. These changes can lead to an increase in conditions conducive to disease development.

Changes in temperature and precipitation affect the growth, composition, quality and availability of different fodder crops. For example, in response to high temperatures, plants grow faster due to stress, resulting in higher carbohydrate content. Consuming these high-carbohydrate plants without adaptation by livestock leads to rapid fermentation in the stomach, contributing to acidosis. Similarly, replacing high-fiber feeds and fodder whose production has been reduced by drought by bought in more fermentable feeds may increase the risk of acidosis and increased gas production potentially leading to bloat and tympany.

Climate change can also lead to variations in the plant growing season, either prolonging or shortening it. A prolonged growing period may result in a greater production and accumulation of secondary metabolites, including toxins which when fed may lead to digestive distress. Similarly, toxins can also be produced in response to a reduced growing period, as part of the plant's defense mechanism against stress factors.

The microbiota present in the stomach of cattle plays a crucial role in the digestive system. However, disrupted and altered diet patterns resulting from climate change, along with variations in feed intake, can impact the microbiota's composition, distribution, and functionality. These changes can ultimately lead to dysfunction in the digestive system of cattle.

**Annex 2 describes Ruminal Tympany and Ruminal Acidosis in detail.**

# Illness Linked to Parasites

80% of the world's cattle are at risk of one or more vector-borne diseases. Farmers also face disease risk as some of these diseases are zoonotic (transmissible to humans) and they have direct, continuous contact with the animals and their environment. Over the last three decades, previously controlled vector-borne diseases have re-emerged or appeared in new geographic areas. Additionally, the resistance (adaptability) of vectors and the pathogens and Protozoa transmitted by vectors to veterinary drugs and insecticides, has increased.

Vectors are external parasites; living organisms that transfer causative agents of diseases, both infectious and invasive, from infected animals to healthy animals and humans. For example mosquitoes, flies and ticks, spread various viruses, bacteria, and protozoa.

Vectors, which are external parasites, are exothermic (i.e., cold-blooded) and are more active in warm climates and weather. Consequently, climate change significantly impacts the geographic expansion of diseases caused by vectors. Warming climates allows their spread to higher latitudes and altitudes, with their activity period increasing and of longer duration in longer, warmer seasons.

Please see Annex 2 which details the symptoms and treatment of four prevalent vector-borne diseases in Georgia: Piroplasmosis, Crimean-Congo Hemorrhagic Fever, Thelaziosis, and Hypodermatosis.

**Table 1 describes the link between climate changes and these respiratory, digestive, and vector-borne diseases as well as management techniques to help counter them.**

Table 1 Diseases Linked to Climate Change

| Disease | Link to Climate Change | Management Techniques<br>*for symptoms and treatment see Annex 2 |
|---|---|---|
| **Digestive diseases in cattle** | | |
| Ruminal Tympany<br><br>*Cattle disease characterized by an excessive volume of gas in the rumen.* | Climate fluctuations can significantly impact the composition of plants utilized for animal feed. Shifts in temperature and precipitation patterns can alter the nutrient content of forage, potentially leading to the loss of es<br><br>sential nutrients crucial for livestock health. Where normal high fiber rations have been degraded or destroyed by bad weather easily fermentable bought in feed such as alfalfa, can escalate gas production and risk of conditions like bloat and tympany if not fed as part of a balanced ration. | - Adjust the diet to ensure a balanced intake of fiber, protein, and carbohydrates, with a focus on high-fiber forages like hay.<br>- Gradually introduce new feedstuffs and limit high-starch grains to prevent rapid fermentation.<br>- Manage grazing practices to maintain optimal forage quality and reduce bloat-inducing legumes.<br>- Ensure constant access to clean water for proper hydration and digestion.<br>- Offer supportive care with electrolytes and fluids during environmental stress or heatwaves. |

| | | |
|---|---|---|
| Ruminal Acidosis<br><br>*A disorder of the digestive system characterized by high acidity in the rumen.* | Ruminal acidosis, a digestive disorder in livestock, is closely linked to climate change. Changes in temperature and precipitation patterns can affect the nutritional composition of forage, increasing the risk of ruminal acidosis. Excessive consumption of grains in substitution for burnt off grazing, particularly high-starch concentrates, can disrupt microbial fermentation in the rumen, leading to acidosis. Rising temperatures and heatwaves associated with climate change can exacerbate heat stress in livestock. Heat stress reduces feed intake and alters digestive function, predisposing animals to ruminal acidosis due to decreased fiber consumption and increased reliance on concentrated diets. | - Ensure access to high-quality forage and gradually introduce new feedstuffs that can minimize digestive disturbances.<br><br>- Providing constant access to clean water is crucial for maintaining hydration and supporting proper rumen function, especially during periods of heat stress or dehydration. |

| Vector borne diseases | | |
|---|---|---|
| Piroplasmosis<br><br>*A tick-borne disease caused by protozoa, affecting cattle with fever, anemia, jaundice and hematuria.* | The link between Piroplasmosis and climate change is increasingly evident, as rising temperatures and altered precipitation patterns create favorable conditions for the proliferation and spread of tick populations. Piroplasmosis tends to be more active under current climate conditions and may present in a more aggressive form, especially in environments with poor ventilation, high temperatures, and humidity, and inadequately ventilated cowsheds. | - Implement pasture rotation to significantly reduce tick populations, as the absence of host animals on the pasture leads to starvation among ticks.<br>- During various stages of development, ticks gather on the surfaces of grass and other vegetation, stealthily attacking nearby livestock. It is crucial to clean the area around the farm from vegetation during this period, including mowing and grubbing bushes.<br>- Treat animals, cowsheds, and surrounding areas with acaricide preparations to control ticks and other vectors.<br>- Dispose of or compost manure.<br>- An affected animal should be kept in a resting position and moved to a cool environment.<br>- Provide high-quality hay and easily digestible feed, such as green and juicy fodder, and ensure access to clean water.<br>- Provide animals with mineral supplements and nutritional additives. |

| | | |
|---|---|---|
| Crimean Congo Hemorrhagic Fever (CCHF)<br><br>*A tick-borne viral disease that does not cause clinical disease in cattle but is a serious high priority zoonotic disease which can be fatal to humans, with cattle as a main source of transmission to people working with and around cattle.* | The link between CCHF and climate change is increasingly evident, as rising temperatures and altered precipitation patterns create favorable conditions for the proliferation and spread of tick populations. Warmer temperatures and changes in vegetation patterns expand the geographic range of tick habitats, allowing them to thrive in new areas previously unsuitable for their survival. This expansion increases the likelihood of human exposure to infected ticks carrying the CCHF virus. | - Contact a doctor immediately for diagnosis and treatment.<br>- Its occurrence must be reported to the relevant authorities<br>- Implement pasture rotation to significantly reduce tick populations, as the absence of host animals on the pasture leads to starvation among ticks.<br>- During various stages of development, ticks gather on the surfaces of grass and other vegetation, stealthily attacking nearby livestock. It is crucial to clean the area around the farm from vegetation during this period, including mowing and grubbing bushes.<br>- Isolate the sick animal to prevent the spread of the disease to other animals and humans.<br>- Implement disinfection of equipment, quarantine procedures for new animals, and control vector populations (ticks).<br>- Use appropriate personal protective equipment such as gloves, masks, and protective clothing to reduce the risk of transmission to humans.<br>- Regularly treat animals and cowsheds with anti-mite preparations (acaricides) from spring to autumn. |

| | | |
|---|---|---|
| Thelasiosis<br><br>*Thelasiosis is an infestation of 'eyeworms', parasitic nematodes of the genus Thelazia and spread by tear feeding flies* | Climate change significantly influences the dynamics of Thelasia transmission by affecting the behavior and habitat suitability of intermediate hosts like pasture flies. As temperatures rise and precipitation patterns shift due to climate change, the abundance, distribution, and activity patterns of pasture flies are affected. Warmer temperatures and altered rainfall regimes can create more favorable conditions for pasture fly breeding, leading to increased populations and higher rates of parasite transmission. | - Keep animal living environments clean and free from debris, including regular rotation to clean pastures.<br>- Conduct regular eye examinations to detect early signs of thelasiosis infection.<br>- Implement measures to control the population of vectors such as flies and other insects that may transmit Thelazia larvae to animals.<br>- Implement quarantine measures for new animals entering the premises |

| | | |
|---|---|---|
| Hypodermatosis<br><br>*Parasitic infection by the larvae of Hypoderma bovis and Hypoderma lineatum, commonly known as botflies who lay eggs which hatch into larvae which bury into the skin and migrate in the body eventually forming nodules under the skin of the back.* | As above. Climate change influences the dynamics of Hypodermatosis. Optimal temperature ranges for development of Hypoderma **pupae have not been recorded but are likely to be in the range 15-25C.** Botflies are active at temperatures above 18 degrees centigrade. | - Keep animal living environments clean and free from debris, including regular rotation to clean pastures.<br><br>- Protect cattle from botfly bites is the most effective method of disease prevention, inspect cattle for eggs for manual removal. Insecticide can be used with caution.<br><br>- Ensure timely treatment of any cattle injuries and promptly remove carcasses of dead animals to prevent the attraction of flies. |

| Respiratory diseases | | |
|---|---|---|
| **Bronchitis**<br><br>*An infection of the main airways of the lungs (bronchi).* | Climate change can exacerbate the risk factors associated with bronchitis in livestock. Bronchitis is often associated with low temperatures and damp, poorly ventilated environments. Climate change can lead to fluctuations in temperature patterns, resulting in unexpected periods of cold weather or unseasonably low temperatures. These conditions create stress on the respiratory system of livestock, making them more susceptible to respiratory infections. Additionally, extreme weather events associated with climate change, such as heavy rainfall or prolonged cold snaps, can exacerbate the spread of bronchitis by creating damp and poorly ventilated environments in cowsheds. | - Severe cases of bronchitis necessitate prompt veterinary intervention.<br><br>- Animals with severe bronchitis should be moved to minimize stress and facilitate treatment. Proper housing and management of affected animals can aid in reducing the spread of the disease within the herd and prevent secondary infections.<br><br>- Antibiotics are reserved for extreme cases of bronchitis, particularly those caused by bacterial pathogens.<br><br>- Biological supplements, such as probiotics, prebiotics, and immunomodulators, can help strengthen the animal's immune response and improve overall health |

| | | |
|---|---|---|
| Bronchopneumonia<br><br>*An infection of the main airways of the lungs (bronchi) most frequently observed among adolescent animals characterized by inflammation of the mucous membrane of the small bronchi.* | Climate change can lead to unseasonable cold spells and frost, which in addition to other contributing factors such as poor air quality in cowsheds, exacerbated by factors such as high levels of ammonia, dust, and mold, can lead to bronchopneumonia. Increased temperatures combined with high humidity can create environments conducive to the survival and spread of respiratory pathogens, increasing the risk of infection. | - Severe cases of bronchopneumonia necessitate prompt veterinary intervention.<br><br>- Animals with severe bronchopneumonia should be moved to minimize stress and facilitate treatment. Proper housing and management of affected animals can aid in reducing the spread of the disease within the herd and prevent secondary infections.<br><br>- Antibiotics are reserved for extreme cases of bronchopneumonia, particularly those caused by bacterial pathogens.<br><br>- Biological supplements, such as probiotics, prebiotics, and immunomodulators, can help strengthen the animal's immune response and improve overall health. |

# Boosting Immunity

Climate change exacerbates the spread of various diseases; non-communicable, infectious, and parasitic, which can compromise the immune system. With shifting temperatures and humidity levels, maintaining a robust immune system becomes increasingly vital. The entire organism functions as a cohesive system in bolstering immunity, with resistance and immunity being key factors in warding off infectious agents.

Resistance denotes an organism's ability to withstand pathogenic agents. A robust immune system is paramount in navigating numerous challenges. The foundation for immune strength is laid during the embryonic phase, and for newborns, passive immunity acquired from cow's colostrum is paramount. Thus, ensuring optimal conditions for pregnant cows to minimize heat stress is crucial.

To bolster an animal's immune system during stress, providing well-balanced nutrition rich in biological supplements, encouraging physical activity, ensuring fresh air, minimizing stress, and administering vitamins are essential. Vitamins, particularly vitamin E and selenium (Se), play pivotal roles in enhancing resistance and combating infectious diseases, especially during heat stress. Vitamin E, also known as tocopherol, is crucial for reproduction and fertilization. Its deficiency can lead to metabolic disruptions, ovarian degeneration resulting in infertility, reduced sperm production in males, anemia, weakness in newborns, and loss of appetite. Tocopherol is produced only in green plants; therefore, it should be supplied in the required amount with feed.

## Preventing Overuse of Antibiotics

The suppression of immunity in animals can pave the way for infections and various diseases, posing significant threats to their health and well-being. Overuse and misuse of antibiotics exacerbates this issue. Improper administration of antibiotics when they are not required and will not be effective can lead to bacterial resistance, rendering these medications ineffective in treating targeted diseases when they are really required. This resistance perpetuates a vicious cycle of harm to the organism. To mitigate antibiotic resistance and bolster animal health,

implementing stringent biosecurity measures and stress reduction strategies is imperative.

Furthermore overuse of antibiotics can harm the environment in terms of the transmission of drug resistant bacteria in manure to soil and into water courses.

**It is essential to understand the limitations and risks associated with antibiotic use:**

- Antibiotics are effective solely against bacterial infections, not viral illnesses.
- They should not be used indiscriminately as fever reducers.
- Prolonged antibiotic use can trigger allergies and increase the risk of life-threatening reactions.
- Overuse of antibiotics may lead to dysbiosis and fungal infections, underscoring the importance of judicious antibiotic management.

**Key measures to combat overuse of antibiotics:**

- Maintaining cleanliness through frequent washing and disinfection of cowsheds is essential. This practice minimizes the transmission of pathogens, thereby reducing the need for antibiotics.

- Providing animals with a well-rounded and nutritious diet is crucial. Balanced feeding ensures optimal health and fortifies the immune system, reducing susceptibility to infections.

- *Utilization of Prebiotics and Probiotics*. Probiotics offer a modern and highly effective approach to antibiotic avoidance. These live microorganisms, including yeast and bacteria, foster a healthy digestive system by restoring and balancing intestinal flora, inhibiting the growth of intestinal pathogens. Probiotics exert preventive and healing effects on gastrointestinal issues caused by poor nutrition, antibiotic overuse, and stress. They alleviate intestinal permeability, thereby reducing the risk of

diarrhea. There are no contraindications to their use or withdrawal periods. Prebiotics feed beneficial microorganisms in the rumen including those delivered in the form of probiotics optimizing the gut biome and enhancing immunity, digestive efficiency and subsequent productivity.

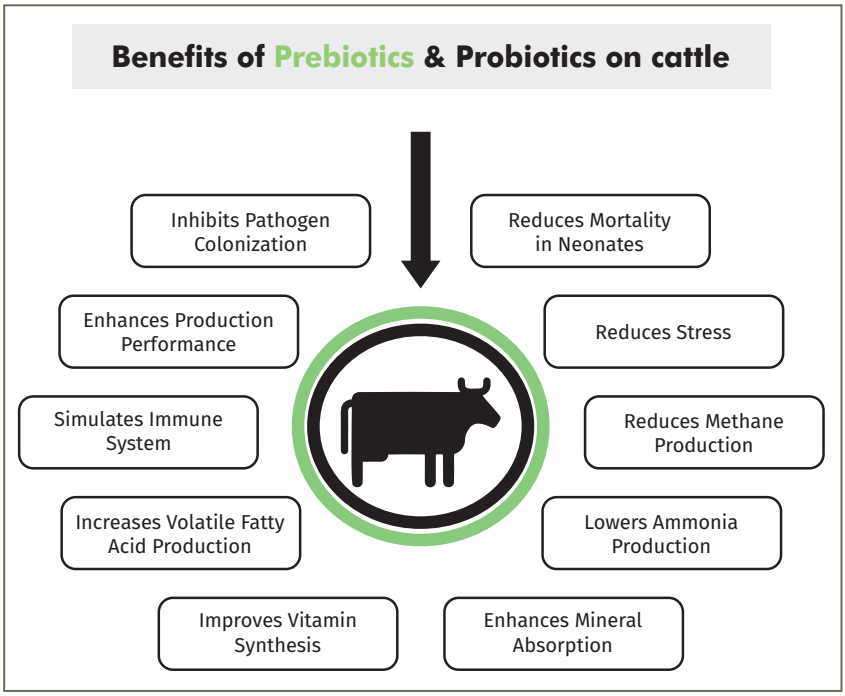



*Figure 5 Illustration of Benefits of Prebiotics and Probiotics*

# Chapter 3: Fodder Production

Chapter 3 looks at the importance of some aspects of soil and crop management to mitigate the amplified effects of heat, low temperatures or frost, and more extreme or unpredictable weather events such as heavier rain or storms, on fodder production. Land provides feed for livestock from pasture for grazing and hay but also from plots cultivated for the production of livestock nutrition in the form of fodder crops.

Climate change is leading to more frequent, extreme and unpredictable weather events and violent temperature fluctuations that exacerbate traditional climatic features in different geographical localities in Georgia, such as higher temperatures and lower rainfall in some lowland areas of Geogia. This leads to a reduction in the quality and quantity of production, crop despoilation and land degradation. Increased and more prolonged heat and periods of drought are causing the loss of soil fertility through soil erosion and soil compaction. Flooding and flash floods have become more frequent and intensive, resulting in damaged crops and soil erosion through run off. Heavy rain and storms also increase lodging in more mature crops leading to significant production losses. For livestock farmers, these impacts manifest in poorer quality feed and reduced nutrient availability.

At the end of this chapter, training participants will know what kind of solutions farmers can employ to begin to counter climate related adversities such as enhancing the water-holding capacity of the soil, minimizing water evaporation, implementing reduced or no-till technology, planting windbreaks, adhering to certain sowing practices, judicious use of fertilizers, and embracing crop rotation methods.

**Learning objectives**

Participants will:

- Understand how climate changes are contributing to land degradation and its implications for agricultural productivity.
- Explore various ways for combating land degradation and enhancing soil preservation, for example by increasing water-holding capacity, adopting no-till or reduced till agriculture and planting windbreaks.
- Recognize the challenges posed by excessive rainfall and storms on crop yield and explore measures to mitigate losses such as by selecting appropriate crop varieties, employing cross-sowing techniques, and balanced fertilizer application.
- Select appropriate forage crops for cultivation e.g. drought tolerant varieties.

# Land Degradation

Land degradation and soil erosion represent a major challenge for agriculture across both East and West Georgia which is being exacerbated by climate change in arid regions. Dry soil is particularly vulnerable to wind erosion due to its susceptibility to soil particle displacement. The vitality of soil organisms cannot be understated in maintaining soil fertility. These organisms play a pivotal role in the accumulation of humus, which is essential for soil health. However, prolonged dry spells drive soil organisms deeper into the soil profile or result in their demise, leading to the depletion of soil fertility - a defining characteristic of degraded soil.

*Figure 6 Illustration of Land Degradation*

In areas where higher rainfall is more prevalent, runoff and landslides can be considerable, especially on land that is denuded of vegetation or where cultivation has taken place on steep slopes. When rain falls on bare soil, particularly on sloping land or compacted ground, it accelerates runoff, carrying away valuable topsoil and nutrients.

**To combat land degradation effectively, several strategies merit consideration:**

- Increasing the water-holding capacity of soil and minimizing water evaporation are critical steps to retain moisture. Employing techniques such as mulching and incorporating organic matter into the soil can help.
- Mulching involves covering the soil surface with materials such as straw, leaves, or plastic film to create a protective barrier. This helps reduce water evaporation from the soil surface by shielding it from direct sunlight and wind. Mulch also helps regulate soil temperature, suppress weed growth, and prevent erosion.

- Incorporating organic matter, such as compost or manure, into the soil improves its structure and porosity, allowing it to better absorb and retain water.

- Minimizing cultivation: Adopting minimal or no-till technology can help preserve soil structure**:** no-till agriculture preserves soil structure and reduces erosion by refraining from ploughing. This approach minimizes soil disturbance, maintains organic matter levels, and enhances water infiltration, thus promoting soil health and resilience.

- Planting windbreaks, trees or shrubs, along field boundaries can shield crops from wind erosion. These natural barriers mitigate wind velocity, helping reduce soil erosion, and provide additional benefits like providing a habitat for beneficial organisms.

Choosing crop varieties suited to local conditions, including drought tolerance and pest resistance, can optimize yields and mitigate the impacts of land degradation.

- Adopting alternative sowing techniques: Sowing seeds in two directions (cross-sowing) helps to optimize sunlight, water, and nutrient availability for each plant, resulting in more consistent growth and yields. It helps to reduce soil erosion by providing better ground cover. The interlocking rows of crops help to hold soil in place, minimizing the risk of erosion caused by wind or water runoff. It can help suppress weed growth as the dense canopy created by the interlocking rows of crops shades the soil, reducing weed germination and growth. The alternating rows of crops create a more porous soil surface, allowing for better infiltration of rainfall and reduced surface runoff. This helps to conserve water and minimize the risk of waterlogging or soil compaction. Cross sowing involves dividing the total seed lot into two equal halves. The first half of the seed is sown in one direction, and then the remaining half is sown perpendicular to the first direction at a distance of 15cm between rows. See Figure 7.

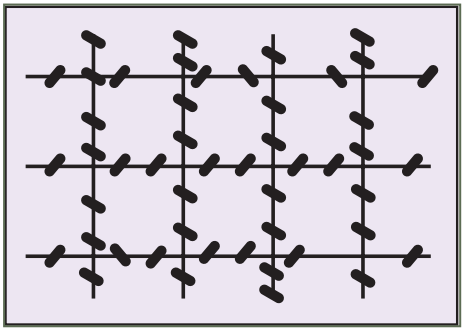


*Figure 7 Illustration of Cross-sowing Technique.*

- Balanced application of fertilizers, including organic and synthetic options, is crucial for maintaining soil fertility without exacerbating degradation. Employing soil testing and precision application techniques will help to ensure balanced nutrient levels while minimizing environmental impact.

## Enhancing Soil Water-Holding Capacity

The water-holding capacity of soil is a crucial attribute that dictates its ability to retain moisture within its structure. This capacity is primarily determined by the soil type, specifically the composition of sand and clay particles. Clay soils inherently possess greater moisture retention capabilities than sandy soils. While altering the soil type itself may not be feasible, the quantity of humus within the soil can be manipulated to enhance water retention. Humus, a key component of soil organic matter, plays a pivotal role in augmenting the soil's ability to hold water, particularly in sandy soils. Humus is formed through the decomposition of organic matter, such as plant residues, animal manure, and other organic materials, by soil microorganisms. Humus is characterized by its dark color, spongy texture, and high nutrient content.

Sufficient levels of humus, foster the formation of bonds, notably clay-humus complexes, between mineral components within the soil. These complexes bolster soil structure, facilitating improved water and

air distribution throughout the soil profile, thereby promoting optimal conditions for plant root development. Remarkably, humus exhibits an exceptional capacity to retain water, holding approximately three to five times its weight in moisture.

**Minimizing soil water evaporation:**

To mitigate water evaporation from the soil, adherence to specific guidelines is paramount. Avoiding soil compaction through the repeated use of heavy equipment, refraining from excessive soil cultivation, and maintaining adequate levels of humus are essential strategies.

- Minimize soil cultivation: over-cultivation of soil disrupts its natural structure and accelerates humus depletion. This loss of organic matter diminishes the soil's moisture-retaining capacity. Adopting conservation tillage practices, like reduced tillage or no-till methods, conserves soil moisture and minimizes evaporation.

- Maintain humus levels: regular soil cultivation can deplete humus content, diminishing the soil's ability to retain moisture. Employing organic farming practices, such as incorporating crop residues and compost, replenishes humus levels and promotes soil health.

- Windbreak placement: the strategic planting of windbreaks plays a pivotal role in mitigating water losses from the soil surface. Windbreaks serve as a natural barrier, slowing down wind velocity and reducing the rate of evaporation from the soil surface. Additionally, they provide numerous ancillary benefits, including erosion control, microclimate moderation, and habitat creation for beneficial organisms.

- Mulching involves covering the soil surface with materials such as straw or crop residues to create a protective barrier on the soil which reduces water evaporation from the soil surface by shielding it from direct sunlight and wind. If organic materials are used they will act as a soil conditioner as they breakdown, increasing soil water holding capacity as they gradually degrade.

## Counteracting Heavy Rain and Storms

When climate change results in excessive rainfall and storms, it is crucial to take appropriate actions to avoid losses, especially since grain crops are particularly vulnerable to damage from storms and heavy rain, causing plants to 'lodge' i.e. be flattened in the field. In most cases, when crops are flattened, the yield is significantly reduced. In response to this, several measures can be taken:

- Select varieties that are resistant to lodging. These can include varieties with shorter or stronger stalks.

- Balanced fertilizer application. Nitrogenous fertilizers, in particular, require careful management to avoid the unintended consequences of rapid leafy growth. Excessive nitrogen can lead to rapid growth and taller crops, making them more susceptible to lodging during storms and heavy rains. In regions prone to such weather events, it is crucial to apply fertilizers judiciously, opting for minimal, balanced, and gradual doses. This approach fosters sturdy crop growth without compromising resilience to adverse weather conditions.

- In areas susceptible to frequent flooding or drought, organic fertilizers such as compost and manure offer sustainable fertilizer alternatives. Organic fertilizers not only supply essential nutrients to crops but also improve soil structure and water retention capacity, enhancing resilience to extreme weather events.

- Crop rotation is a time-tested method for optimizing soil health and crop productivity. Crop rotation is a practice where different types of crops are grown on the same area in a specific sequence, over seasons or years. The systematic rotation of specific crops are chosen to improve soil health, manage pests and diseases, and optimize yields by alternating the types of crops grown and their nutrient requirements. When crops with tall stature, such as maize or sorghum, are planted in succession without proper rotation, they can deplete soil nutrients more rapidly and leave behind residues that contribute to increased plant height in subsequent crops. The accumulation of plant material and competition for nutrients can lead to taller and weaker stems, making the plants more prone to lodging, where they

bend or collapse under their own weight or external stresses like wind or rain. Proper crop rotation helps break this cycle by diversifying the types of crops grown and their nutrient demands, reducing the risk of excessive plant height and lodging while promoting overall soil health and productivity. Careful planning is crucial to ensure that the fertilizer applied in preceding years does not lead to overly vigorous crop growth. Incorporating annual forage grasses, biennial grass mixtures, or adopting cross-sowing techniques can help diversify crop rotations and mitigate the risk of lodging.

*Figure 8 Illustration of Lodging*

# Choosing Varieties to Optimize Fodder Production

Climate related weather effects such as drought, heavy rain, frost or hail can seriously impact fodder production for livestock, therefore it is doubly important to choose fodder types which are better adapted to the type of weather constraints likely to be amplified in varied localities. For example, drought in hotter lowland locations or prolonged low temperatures and unseasonal frost in more mountainous locations.

It is important to consider the biological characteristics of each crop. To produce fodder in drought prone conditions, it is important to understand the drought resistance of different varieties of different crops. Or conversely which variety can tolerate or will do well in a wetter environment and weigh this against potential yield. Among perennial forage crops, lucerne (alfalfa) is the most popular crop cultivated in Georgia. The most widespread varieties are blue-eyed lucerne and yellow lucerne. Yellow lucerne is more resistant to drought and can withstand severe winters, but blue-eyed lucerne provides a higher yield. Like yellow lucerne, sainfoin is resistant to drought and is a quick growing crop completing its growth in spring whilst there is still sufficient moisture. Lesser trefoil is another crop that is resistant to drought, however, it is better to sow it as part of a grass mixture rather than a pure crop since the grass mixture better meets cattle's' feed requirements and is also more drought resistant.

**In dry zones mixtures of sainfoin or lucerne can be used and clover mixtures in humid zones**

**Table 2 Recommended Fodder Crop Mixtures for Dry and Wetter Zones**

| **Dry Zones Mixtures per 100m$^2$** | | **Sowing standard** |
|---|---|---|
| **Lucerne mixture** | Lucerne - 150g<br>Red clover – 20g<br>Cocksfoot (Dactylis glomerata) – 60g<br>Meadow fescue (Festuca pratensis) – 120g<br>Phleum (Timothy) – 30g | 380g/100m$^2$= 38 kg/ha |
| **Sainfoin mixture** | Sainfoin – 1000g<br>Cocksfoot (Dactylis glomerata) – 30g<br>Lolium multiflorum – 80g<br>Meadow fescue (Festuca pratensis) – 100g | 1210g/100m$^2$=121 kg/ha |
| **Wetter Zones Mixture** | | |
| **Clover mixture** | White clover – 40g<br>Meadow fescue (Festuca pratensis) – 80g<br>English ryegrass (Lolium perenne) – 30g<br>Red fescue (Festuca rubra) – 40g<br>Meadow foxtail – 80g<br>Meadow grass – 100g | 370g/100m$^2$ =37 kg/ha |

# Conclusion

These guidelines underscore the urgency of addressing the challenges exacerbated by changing climatic conditions in cattle production. By equipping training participants with the necessary knowledge and skills, adaptability can be built into livestock production systems, ensuring resilience in the face of ongoing climate change.

In the first chapter, participants learnt to identify and mitigate the negative effects of temperature and humidity fluctuations on livestock. Understanding the importance of proper airflow, recognizing risks associated with extreme weather, and gaining the ability to adapt husbandry practices to safeguard livestock production.

In the second chapter, the focus shifted to the connection between climate change and disease incidence, as well as the proliferation of parasites. Participants grasped how climate-induced events impact nutritional aspects of animal feed and can now evaluate the effects of temperature fluctuations on animal immune systems. They learnt how to adopt best practices for disease control and adapt husbandry methods accordingly.

The third chapter provided strategic solutions to counter adversities like drought and extreme weather. Participants learnt techniques for improving fodder quality through understanding practices of preserving and enhancing soil structure, fertility and water-holding capacity and optimal crop choices in the face of exacerbated climate challenges.

The training in this manual offers a catalyst for positive change, instilling enthusiasm for inclusive innovation in extension efforts to build resilient livestock production systems for all people dependent on their cattle for their livelihoods. With the dedication and determination of extension specialists using this manual, it is intended that challenges be turned into opportunities, paving the way for a more sustainable and prosperous future for all.

# Annex 1
# Harmful Gas Accumulation

The accumulation of harmful gases in inadequately ventilated cattle housing has a deleterious effect on the overall well-being and reduces their ability to cope with the effects of heat and cold stress. Special attention should be paid to the accumulation of harmful gas on the farm.

Ventilation is the most important measure to reduce the high concentration of harmful gases that can accumulate in a poorly ventilated cowshed. Under their influence, some pathological changes take place in the animals which reduce the resistance of the organs and are predisposing factors of diseases.

**The main harmful gases in a cowshed are:**

- carbon dioxide
- ammonia,
- hydrogen sulfide
- carbon monoxide

In most cases, prolonged exposure of cattle to higher carbon dioxide content in a non-ventilated building leads to irreversible pathological changes. Even with minimal concentrations, disruptions in oxidation-regeneration reactions occur in the tissues, leading to increased acidity, swelling, and bone demineralization. Studies have shown that increasing the carbon dioxide content in the air to 0.5% results in elevated blood pressure, breathing rate, and pulse, thereby overloading the respiratory and circulatory organs.

**The following quantity of harmful gases are allowed in the air of animal cowsheds:**

**- carbon dioxide - no more than 0.15-0.3%**

**- Ammonia - 0.02 - 0.025%**

**- carbon monoxide - 0.005 %**

**- Hydrogen sulfide - 0.001 %**

When the carbon dioxide content reaches 4-5%, cattle experience a decreased appetite, and their weight gain diminishes rapidly. Asphyxia can develop due to a lack of oxygen at higher concentrations of carbon dioxide. While accumulation of carbon dioxide in the animal cowshed at doses causing acute toxic events is rare, its content often exceeds 1%, which is sufficient for the development of chronic toxic processes. In such cases, the productivity of the animals decreases, and their resistance to diseases diminishes.

Hydrogen sulfide is a highly toxic gas formed during the decomposition of sulfur-containing proteins, which are present in large quantities in cowsheds with poor sanitation. Sometimes, cattle can directly emit hydrogen sulfide when fed with high-protein-based feed. The gas is absorbed by the body from the lungs and mucous membranes of the upper respiratory organs. If the content in the air exceeds 0.015 %, it poses a danger to both livestock and human health. Hydrogen sulfide can disrupt the normal functioning of some animal organs or completely disable them. Symptoms of exposure include light sensitivity, loss of appetite, anxiety, vomiting, and diarrhea in animals. Prolonged low-level exposure to hydrogen sulfide typically leads to chronic poisoning, manifested by general weakness, weight loss, development of conjunctivitis, catarrh of the upper respiratory organs and gastroenteritis.

Ammonia is produced by the decomposition of nitrogen-containing substances. Buildings where manure and litter are not removed promptly and ventilation is irregular or incorrect tend to have high levels of ammonia. In conditions of high humidity and low temperature, ammonia precipitates on walls, furniture, litter, and other objects. When temperatures rise and atmospheric pressure decreases, ammonia is released back into the air, quickly increasing its concentration in the building.

Even a small concentration of ammonia in the air can be dangerous. Ammonia is water-soluble, so it quickly affects the upper respiratory tract and the mucous membrane of the eyes, causing irritation, coughing, sneezing, and tearing of the eyes. Subsequently, inflammation of the mucous membrane of the nose, esophagus, trachea, and bronchi may develop.

When ammonia comes into contact with wet skin, it combines with oxygen to form a toxic compound called nitrate, which irritates the skin. Large amounts of ammonia entering the blood can affect the central nervous system, causing irritation that is often accompanied by paralysis of the respiratory organs and even death in animals.

With small doses of ammonia, long-term exposure can lead to oxygen deficiency and decreased function of several organs. Livestock eat poorly, and become weak, their body's resistance decreases, and the protective function of the mucous membrane and skin diminishes. Microbes and viruses can easily enter the body through compromised mucous membranes and skin, contributing to the emergence and rapid spread of respiratory and other infectious diseases.

Carbon monoxide can accumulate in the cowshed during the prolonged operation of internal combustion engine units, for example, tractors. When cattle inhale this gas, it binds to hemoglobin, reducing the ability of blood to carry oxygen to the tissues. Animals can become sick or even die if a large amount of carbon monoxide accumulates in the cattle shed.

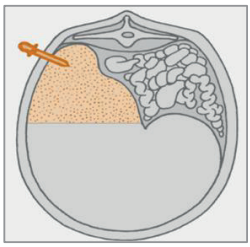
Methane, while relatively less toxic compared to carbon monoxide, still has significant effects on the animal's body and can disrupt several of its functions.

# Annex 2
# Animal Diseases Exacerbated by Climate Change

**This Annex is organized into digestive, respiratory and vector borne diseases.**

## Digestive Diseases

### Ruminal Tympany



Although climate change does not directly cause tympany, it indirectly affects livestock health by inducing environmental conditions that influence feed content, quality, availability, and changes in grazing patterns. These changes can lead to an increase in conditions conducive to disease development.

Unstable levels of humidity and temperature can lead to changes in the composition of plants used for animal feed which can lead to increased gas production in livestock. This, in turn, raises the risk of bloat and tympany in animals.

Causes of ruminal tympany include the intake of a large amount of easily perishable feed, as well as providing animals with dewy or wet feed. Secondary tympany may result from the ingestion of toxic plants.

Primary tympany occurs when animals consume large amounts of feed that are prone to fermentation and gas production, for example, freshly cut alfalfa, clover, burclover, sweet corn, and beet leaves. High temperatures or sudden temperature changes can accelerate this fermentation

process. Moisture from rainwater on pastures can further facilitate rapid fermentation in these feedstuffs. Tympany can also be triggered by sudden drops in temperature, frosts, frozen roots, poor-quality silage, mouldy hay, and piled and overheated green fodder.

The disease can develop when animals are rapidly transitioned from dry storage to pasture or from dry fibrous fodder such as hay or maize stover to green feed such as alfalfa. Microorganisms in the rumen quickly decompose the ingested green mass, releasing large amounts of gases. As a result, the rumen expands significantly, pushing against the diaphragm, lungs, and heart. Without intervention, death can occur within 1.5-2 hours.

In severe cases, animals may exhibit restlessness, repeatedly look at their stomachs, stand hunched over, and beat their hind limbs against their stomachs. Breathing becomes rapid, the left flank bulges, producing a drum-like sound upon tapping. The visible mucous membranes may appear blue, and the animal may stagger.

During diagnosis, secondary tympany, which can result from complete obstruction of the esophagus, poisoning, or certain acute infectious diseases, must be ruled out.

**Treatment:**

- Drugs are administered to stop or weaken the rumbling process in the rumen.
- Oils are given to the animal to prevent foaming in the rumen. Additionally, these oils act as laxatives, aiding in the emptying of the anterior stomach and intestines.
- Accumulated gas can be expelled from the rumen using a probe or rubber tube.
- If these measures fail to alleviate the condition, veterinarians may resort to puncturing the rumen with a trocar to release trapped gases and save the animal.

**Recommendations:**

- Cattle are taken slowly uphill. The anterior stomachs move back, no longer touch the diaphragm, improving gas exchange and restoring the belching reflex.
- To activate the belching reflex, cattle are encouraged to stick out their tongues rhythmically using a belt, bandage, large thread, or other items pre-moistened with an irritant.
- In some cases, deliberate stress is induced in the cattle's body; for example, cold water is poured into the cattle's stomach pit. Additionally, probing is used to release gases, tympanal is administered to prevent gas formation, and tincture vera is used for rumination.
- If the condition of the animal does not improve, a trocar is used to puncture the rumen.
- It is necessary to consider rumen pressure; gases from the rumen should be expelled at a slow intensity to avoid sudden drops in pressure, which can lead to various complications, for example brain anemia.
- Trocars should not be left in the rumen for a long time to avoid inflammation.
- After the treatment, it is recommended to follow a specific diet.
- Starvation is recommended during the first 24 hours, followed by feeding animals small portions 5-6 times a day.
- If the animal is free from gas and has been saved, it is important to provide them with easily digestible feed and create optimum environmental conditions.

# Ruminal Acidosis

Acidosis is a metabolic disease of cattle. The disruptions caused by climate change in terms of temperature and precipitation, affects the culture of feed, its growth, and quality. For example, in response to high temperatures, plants grow faster due to stress, resulting in higher carbohydrate content. Consuming these high-carbohydrate plants without adaptation by livestock leads to rapid fermentation in the stomach, contributing to acidosis. Similarly, using more readily fermentable but readily available feeds instead of high-fiber feeds, whose production has been reduced by drought, increases the risk of acidosis.

An unbalanced diet, low-quality feed, excessive amounts of grain in the diet, heat stress, and a limited variety of both succulent and dry feed are the causes of the disease. The condition is characteristic of high-yielding animals within 20-40 days after calving and, in most cases, leads to the animal becoming unproductive or dying.

Ruminal acidosis is a disorder of the digestive system characterized by high acidity in the rumen, caused by excessive production of acids and insufficient incorporation of saliva. An increase in environmental temperature is accompanied by difficulty breathing and excessive salivation. When salivation increases, if it is accompanied by a lack of water, a sufficient amount of saliva does not enter the animal's rumen hindering digestion.

There are two types of acidosis: acute and chronic. Acute acidosis presents clear clinical signs, while chronic acidosis proceeds in a hidden form. Acute acidosis can be detected a few hours after feed intake when the cattle's appetite decreases partially or completely. Shortly thereafter, accompanying symptoms for example anorexia, atonia, respiratory arrest, and tachycardia may occur. The animal experiences rapid weakness, making it difficult for them to stand, and they may prefer to lie down. Other symptoms include a dry nose, a coating on the tongue, a swollen abdomen, shivering, and a normal body temperature. In severe cases, a specific odor emanates from the rumen, and the hemoglobin level drops rapidly. The rumen pH decreases to 4, and protein may be found in cow urine.

Table 1 Acidity Index

| Acidity index | PH | Result |
|---|---|---|
| **Normal** | 6.0-6.5 | Good rumen function |
| **Slightly acidic** | 5.5-6.0 | The number of rumen contractions is reduced, and the digestion of the cell is complicated |
| **Moderately acidic** | 4.5-5.5 | Sick animal |
| **Strongly acidic** | 4.0-4.5 | A fatal outcome is likely |

**Symptoms:**

- The animal behaves uncontrollably, exhibits reduced appetite or aversion to grains or starch, experiences slowed rumen mobility, and shows signs of anemia in visible mucous membranes, accompanied by diarrhea.
- The disease affects productivity by decreasing milk fat, pH, and infusion levels.
- The disease is common on farms where the concentration of concentrates and carbohydrates in the feed is high. The onset of lactation is the most likely period for its development.
- During acute acidosis, substances are released into the bloodstream, which contribute to the development of laminitis (inflammation of the hooves), weakening the tissue of the hooves and resulting in lameness in animals.
- Milk yield decreases, and the milk may foam, have high acidity, and reduced lactose levels. Following acidosis, the development of ketosis is common. Due to the presence of a large number of ketone bodies in milk, it acquires a bitter taste and smells of acetone.

- Milk fat content decreases. Milk fat is formed by the joining of acetic acid molecules; however, during acidosis in the rumen, there is a higher concentration of propionate and a lower concentration of acetic acid, leading to a decrease in milk fat content.

**Treatment:**

- A 3-5% solution of sodium carbonate (baking soda) is recommended orally for the treatment of mild cases.
- In complicated cases, it is necessary to rinse the rumen by injecting 20-40 liters of liquid into the rumen (1% sodium chloride) until the rumen content loses its smell and becomes neutral or weakly alkaline.
- In cases of metabolic acidosis, in addition to the above-mentioned treatments, 300-500 ml of Ringer's solution is injected intravenously to prevent dehydration.
- For the rapid restoration of infusoria after improvement of acute acidosis, 200 grams of yeast, 1.5 liters of milk, or 2-4 liters of rumen content from a healthy animal are prescribed. Additionally, probiotics are recommended for a certain period to promote the development of beneficial microflora in the rumen and intestines.

**Recommendations:**

- Stop feeding concentrates during illness.
- Include high-quality straw and stover in the ration. The amount of concentrate should not exceed 2 kg per meal.
- Ensure that roughage constitutes at least 50% of the total ration.
- Baking soda can be administered in amounts of 100-250 grams along with concentrate.
- It is effective to administer 60-360 grams of calcium carbonate (chalk) daily per head of livestock.

# Respiratory Diseases

## Bronchitis

Bronchitis is an inflammation of the mucous membrane of the bronchi. Inflammatory processes can be catarrhal, purulent, hemorrhagic, and fibrinous. The occurrence of the disease is related to low temperatures, as well as other unfavorable storage conditions, for example moisture and lack of ventilation in the cowshed. Additionally, high levels of ammonia, hydrogen sulfide, dust, and moldy feed particles in the air, as well as the intake of low-quality feed and exposure to cold, contribute to the onset of the disease. Animals typically fall ill in early spring and late autumn while on pasture during cold, rainy weather.

In the case of macro bronchitis, the animal's condition is relatively satisfactory. The temperature may rise slightly, and symptoms for example reduced appetite, quick fatigue, coughing, and wheezing in the lungs are observed. Wheezing can be dry or wet. On the other hand, in the case of micro bronchitis, the animal's condition worsens. It appears sad, with an elevated temperature, difficulty in breathing, and blue mucous membranes. Without complications, the disease typically resolves within 2-3 weeks. However, if the animal fails to recover promptly, the disease can become chronic, resulting in decreased productivity and weight loss. Additionally, the disease may become acute in cold weather.

The disease is diagnosed based on clinical signs. Infectious and invasive diseases should be excluded.

**Treatment:**

- Before treatment, the animal should be in a stable condition.
- Antibiotics are reserved for extreme cases.
- Sulfonamides and expectorants are administered to animals.

**Recommendations:**

- Animals should be protected from drafts.
- Proper conditions should be provided for feeding and storage.
- An animal's immune system should be strengthened by adding biological supplements to the feed ration.

## Bronchopneumonia

Bronchopneumonia is most frequently observed among adolescent animals and is characterized by inflammation of the mucous membranes of the small bronchi and separate fractions of the lungs. The disease is caused by various factors, for example exposure to cold, toxic gases, dust, and microorganisms. Contributing conditions include inadequate care, storage, and feeding practices, as well as insufficient exposure to UV radiation, all of which weaken the animals' immune systems. During the inflammatory process, harmful products are formed, and toxins produced by microorganisms can lead to poisoning of the animals' bodies. Clinical signs of bronchopneumonia include high temperature, loss of appetite, increased heart rate, coughing, nasal discharge, and wheezing during auscultation of the lungs.

**Treatment:**

- Before treatment, an animal should be moved to a suitable environment.
- Antibiotics are reserved for extreme cases.
- Sulfonamides and expectorants are prescribed for animals.

**Recommendations:**

- Animals should be protected from drafts.
- Proper conditions should be provided for feeding and storage.
- An animal's immune system should be strengthened by adding biological supplements to the feed ration.

## Piroplasmosis

Piroplasmosis is a severe acute disease caused by the protozoan parasite Babesia bigemina. It typically manifests during the seasonal pasture period, presenting with constant fever, anemia, jaundice, and hematuria. The disease is prevalent across all continents, primarily in southern zones where vector ticks are abundant. With the effects of climate change, the disease has become more active and aggressive.

The disease typically occurs in two or three enzootic outbreaks during spring, summer, and autumn. However, sporadic cases can occur throughout the year, especially in inadequately ventilated cowsheds with high temperatures and humidity.

The initial outbreak of the disease occurs due to overwintered larvae. Piroplasms specifically localize within erythrocytes, particularly in the center of the erythrocytes. The incubation period of the disease can range from 8 to 24 days.

**Symptoms:**

- The disease onset is marked by a high fever, reaching 40-41°C or higher. A drop in temperature to 37°C is considered an alarming condition for the animal.
- Animals exhibit pronounced depression, loss of appetite, and cessation of rumination.
- The pulse rate increases to 110-120 beats per minute.
- Hemoglobinuria becomes apparent on the following day after the temperature rise, accompanied by concurrent occurrences of acidosis and hypoglycemia.
- Initially, the mucous membranes appear anemic, eventually progressing to jaundice. Hemoglobin released from erythrocytes is partially excreted in the urine, while some remains in

the kidneys, where it transforms into a pigment causing jaundice.

- Severe cases may be present with urine tinged with blood.
- At the onset of the disease, intestinal peristalsis intensifies, leading to diarrhea, which subsequently weakens and progresses to atony.
- Milk secretion decreases or ceases altogether in dairy cattle.

**Treatment:**

- The affected animal should be kept in a resting position and moved to a relatively cool environment.
- Offer high-quality hay, easily digestible feed, for example green and juicy fodder, and ensure access to clean water.
- Administer prescribed medications, including antiprotozoal drugs and digestive system regulators. For cardiovascular support, medications like caffeine, vitamins, and immunostimulants may be recommended.
- Delayed treatment may result in the absorption of liquids in the omasum and obstruction by dry feed or fur accumulation. In such cases, drugs aimed at enhancing gastrointestinal motility may be ineffective.

**Recommendations:**

- Treat animals, cowsheds, and surrounding areas with insect acaricide preparations to control ticks and other vectors.
- During crisis situations, while treating the omasum, use oily liquids, cooking oil diluted in hot water (1:1 ratio) at a temperature of 70°C. Apply approximately 2-3 liters of this solution.

## Crimean Congo Hemorrhagic Fever

Crimean Congo hemorrhagic fever is a zoonotic viral disease, primarily spread by ticks, that belongs to the new risk group caused by climate change. It has become more common in Georgia, and farmers should be more aware of how what it is and how to prevent it.

Crimean Congo hemorrhagic fever can affect various animals; cattle, pigs, sheep, goats, and mice. While the disease may occur asymptomatically in animals, it poses a significant threat to humans.

The disease is most prevalent during hot periods of the year, coinciding with the activation of ticks. An early temperature rise can lead to the earlier activation of ticks in spring.

Humans become infected through tick bites, handling ticks from animals with bare hands, or crushing ticks with fingers. Additionally, humans can be infected through contact with infected blood or tissues, for example during slaughtering.

Risk groups for Crimean Congo hemorrhagic fever include:

- Cattle farmers and shepherds.
- Employees of slaughterhouses.
- Veterinarians.

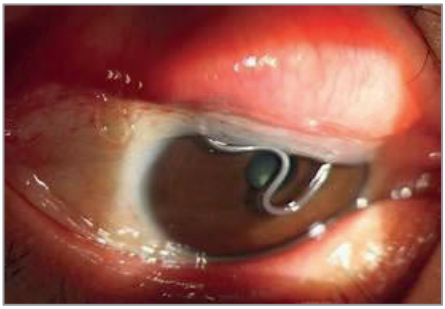
**Symptoms:**

- Fever
- Weakness
- Reduced appetite
- Discomfort or pain
- Reddening of mucous membranes
- Hemorrhagic symptoms such as bloody diarrhea, nasal discharge, and bleeding from injection sites or mucous membranes.
- Neurological signs in severe cases

**Treatment:**

- Isolate the sick animal to prevent the spread of the disease to other animals and humans.
- Contact a veterinarian immediately for diagnosis and treatment. CCHF is a zoonotic disease, meaning it can be transmitted from animals to humans, so precautions should be taken when handling suspected cases.
- Its occurrence must be reported to the relevant authorities. Reporting helps in tracking and controlling the spread of the disease.
- Implement strict biosecurity measures on your farm to prevent further spread of the virus. This may include disinfection of equipment, quarantine procedures for new animals, and controlling vector populations (ticks).
- When handling suspected cases or working in areas where CCHF is present, use appropriate personal protective equipment such as gloves, masks, and protective clothing to reduce the risk of transmission to humans. Preventive measures include regularly treating animals and cowsheds with anti-mite preparations (insecticides) from spring to autumn.

## Thelasiosis



The causative agent of thelasiosis in cattle is Thelazia, a parasitic worm that inhabits the conjunctival sac and the area under the third eyelid. Thelazia requires intermediate hosts for their life cycle, with pasture flies serving as these hosts. The flies ingest the larvae released by female Thelazia, which then develop within the fly's body, undergo skin changes, and reach the invasive stage over the course of about a month. Invasions typically occur during the day in pastures, with the disease manifesting in the summer months. However, changes in temperature patterns can alter the activation period of thelasiosis, causing it to occur earlier in the spring or even in late winter.

**Symptoms:**

- Excessive tearing and aversion to light.
- Redness and swelling of the conjunctiva, along with swelling of the eyelids.
- Reduced appetite and decreased milk yield.
- Neglecting the condition may lead to complications for example keratitis, corneal ulcers, and leukoma. Severe forms of the disease are more common in adolescent cattle (aged 4 months and older).
- Diagnosis is based on clinical signs and the detection of Thelazia larvae in the liquid obtained after rinsing the eyes.

**Treatment:**

- Flushing the conjunctival sac with a 3% solution of boric acid.
- Applying powdered sugar to the eyes to remove a white film, expelling eggs or larvae.
- Ensuring thorough rinsing of the third eyelid with ivermectin.
- Using antibiotic ointment promptly to address inflammation.

## Hypodermatosis (Skin Botfly)

Another disease that becomes active in response to high temperatures is hypodermatosis, which is a chronic condition. It is caused by larvae hatching from the eggs of a hypodermal fly laid on the animal's body (Hypoderma bovis affects the spinal cord, and H. lineatum affects the esophagus).

The main clinical signs include subcutaneous nodules primarily spread across the back area. Diagnosis is typically based on clinical signs and palpation, with nodules being observed in the back region.

**Treatment:**

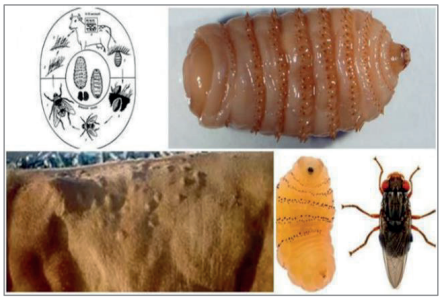
- Administer treatments containing ivermectin to affected animals.
- Use hydrogen peroxide to treat injuries caused by larvae.

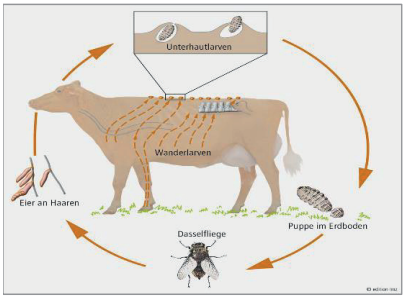
**Recommendations:**

- Implement pasture rotation to significantly reduce tick populations, as the absence of host animals on the pasture leads to starvation among ticks.
- During various stages of development, ticks gather on the surfaces of grass and other vegetation, stealthily attacking nearby livestock. It is crucial to clean the area around the farm from

vegetation during this period, including mowing and grubbing bushes.

- Protecting cattle from skin botfly bites is the most effective method of disease prevention.
- Implement periodic use of acaricides (tick-killing preparations) for tick control. This involves direct treatment of animals and disinfection of their cowsheds and surrounding areas.
- Ensure timely treatment of any cattle injuries and remove carcasses of dead animals promptly to prevent the attraction of flies.





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