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Weather Forecasting: A Decision-Support Tool for Livestock Farmers

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ABSTRACT

Weather forecasting is a scientific process that predicts atmospheric conditions such as temperature, rainfall, humidity, and wind speed at a specific place and time. It plays a crucial role in livestock farming by helping farmers anticipate and manage weather risks, optimize feeding, breeding, and shelter arrangements, and protect animal health and welfare. The Krishi Mausam Seva initiative in India exemplifies a location-specific agrometeorological advisory system that delivers real-time weather forecasts and farm advisories through modern technologies, including Automatic Weather Stations and satellite data. These tools enable proactive management to reduce losses from adverse weather, support climate-resilient agriculture, and improve farm productivity and sustainability.

Key words: AWS, Krishi Mausam Seva, livestock, weather forecast

INTRODUCTION

Weather Forecasting

Weather forecasting is the scientific process of predicting the state of the atmosphere at a particular place and time. It helps anticipate temperature, rainfall, humidity, wind speed, and other meteorological conditions.

Principles of Weather Forecasting

Weather forecasting is based on the understanding of:

- Atmospheric pressure
- Temperature
- Humidity
- Wind patterns

- Cloud formation and precipitation

Krishi Mausam Seva

Krishi Mausam Seva, also known as Gramin Krishi Mausam Sewa (GKMS), is a government initiative managed primarily by the India Meteorological Department (IMD) in collaboration with the Ministry of Earth Sciences and various agricultural institutions. Its main objective is to deliver location-specific, weather-based agro-advisories to farmers, helping them make timely decisions, reduce risks from adverse weather, and increase agricultural productivity.

Key Objectives and Structure

The service collects and analyzes weather data using Agromet Observatories and Automatic Weather Stations (AWS) located at research institutions and Krishi Vigyan Kendras (KVKs). The IMD has established District Agro-Met Units (DAMUs) in over 200 districts, which receive forecasts and generate localized agrometeorological bulletins for farmers. These advisories provide information for managing crops, pests, diseases, soil health, and livestock based on forecasted weather parameters such as rainfall, temperature, humidity, and wind. The bulletins are disseminated through various means to maximize outreach, including SMS, mobile apps, radio, and extension networks.

Major Benefits

Agromet advisories help minimize crop and livestock losses by providing early warnings and weather-based management recommendations. They also support climate-resilient agriculture by integrating scientific weather predictions with practical farm-level advisories. Moreover, they enhance planning for input use (e.g., fertilizers, irrigation) and the scheduling of farm operations according to forecasted weather. These services facilitate research and the development of region- and crop-specific predictive models, supporting both short-term advisories and long-term agricultural planning. Krishi Mausam Seva serves as a vital bridge between meteorological science and field-level agricultural decision-making for millions of farmers across India.

AGRO AWS UNIT (KVK BARAMULLA)

Automatic Weather Station

An Automatic Weather Station (AWS) is a sophisticated, self-operating system designed to monitor and record a wide range of meteorological parameters without manual intervention. These stations use sensors to measure variables such as temperature, humidity, rainfall, wind speed and direction, atmospheric pressure, solar radiation, and sometimes soil conditions.

Role in Agriculture

AWS installations on farms provide hyper-local, real-time data crucial for decision-making in areas such as irrigation scheduling, pest control, fertilizer application, and crop harvesting. The data helps reduce risks associated with adverse weather and improves resource-use efficiency and productivity. These stations are integral to agrometeorological advisory systems like Krishi Mausam Seva, enabling timely and scientific recommendations for farmers.

Modern Weather Forecasting Tools

- **Sensors:** Measure weather elements such as temperature, wind speed and direction, humidity, rainfall, atmospheric pressure, and solar radiation.
- **Data Logger:** Collects and stores sensor data with time stamps, often in real time.
- **Communication System:** Transmits collected data to a central database or remote users via wireless, cellular, or satellite networks.
- **Power Supply:** Utilizes batteries, solar panels, or both to ensure uninterrupted operation even in remote locations.
- **Weather Satellites:** Provide large-scale images and data on cloud cover, storms, and weather phenomena from space.
- **Radar Systems:** Track precipitation, storms, and wind speeds, helping predict severe weather and rainfall.
- **Numerical Weather Prediction Models:** Supercomputers use physics-based mathematical models and global data to generate weather forecasts.
- **Weather Balloons:** Measure atmospheric parameters at various altitudes through the troposphere.
- **Remote Sensing Instruments:** Include ground-based sensors and airborne platforms that monitor environmental changes and improve local forecasts.

Advantages

- Provides accurate, location-specific, and continuous monitoring of environmental conditions.
- Enables early warning systems for extreme events, aiding in disaster preparedness and resilience.
- Supports climate research and policy development through long-term, reliable weather datasets.

Automatic weather stations have become a vital part of modern agricultural practices, offering actionable insights that enhance farm management and sustainability.

Impact of Weather on Agriculture

Rainfall determines water availability and sowing time for rain-fed crops. Temperature influences crop growth, duration, milk production in animals, and fish spawning. Temperature and relative humidity affect pest and disease incidence in crops, livestock, and poultry. Solar radiation drives photosynthetic productivity. Wet and dry spells significantly impact standing crops, physiology, and economic yields (e.g., fruit drop). Extreme events such as floods, heatwaves, cold waves, cyclones, hailstorms, and frost cause severe losses in crops, livestock, and fisheries.

Actions for Livestock Owners Before Extreme Conditions or Storms

Before a storm, livestock owners should take several shelter and feeding measures to protect animals and minimize disruptions.

Shelter Measures

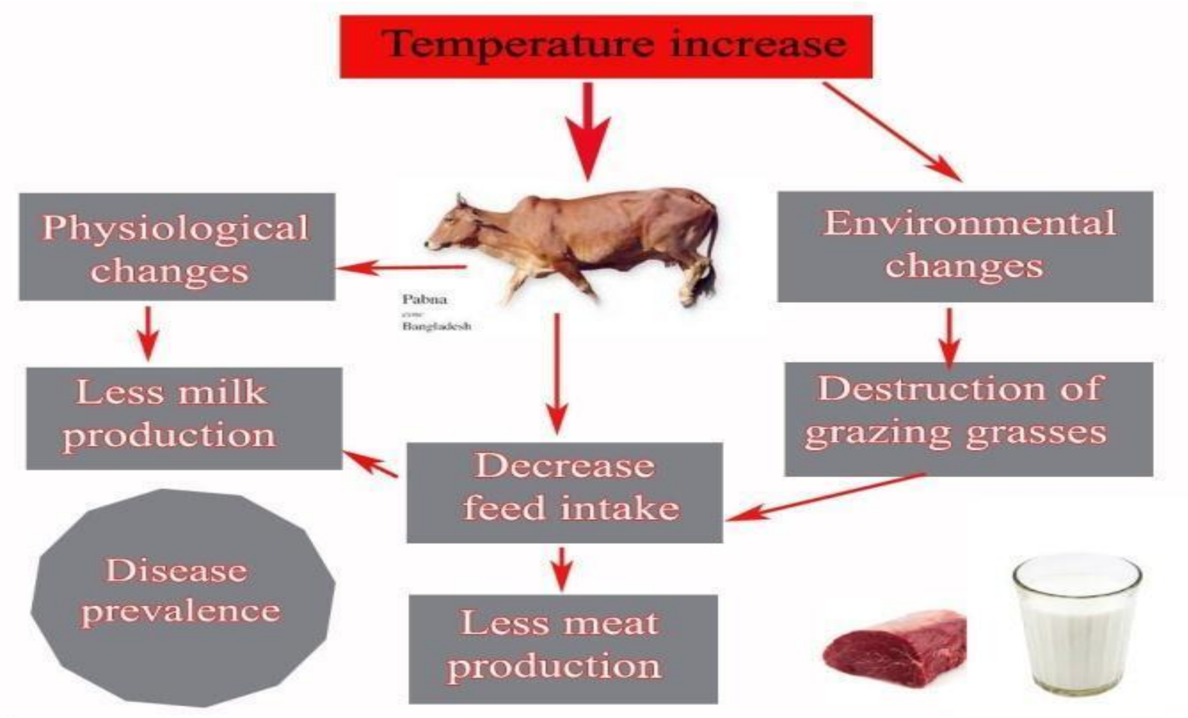
- Ensure livestock have access to a sturdy shelter that can withstand high winds, heavy rain, and flying debris.
- Move animals to high ground away from flood-prone areas. Avoid placing them in closed barns unless the structure is secure.
- Secure or remove loose items around animal enclosures.
- Do not tie animals outside; provide extra bedding for warmth if cold weather is expected.
- Double-check animal identification and ensure backup power or water sources.

Feeding Measures

- Stockpile at least five to seven days' worth of feed and clean water, stored safely and dry.
- Place feed and water away from flood-prone areas and prevent contamination.
- Avoid abrupt changes in diet and do not feed mouldy or spoiled feed.
- Prepare mineral and energy supplements to help livestock cope with stress.
- Monitor animals for signs of distress or feed refusal post-storm.

Effects of Climate Change on Livestock

Climate affects livestock both directly and indirectly. Direct effects—such as changesintemperature, humidity, and wind—impact growth, reproduction, and productivity. Indirect effects occur through reduced feed resources, altered rangeland capacity, and increased disease prevalence.



Physiological Effects

High temperatures reduce feed intake and physical activity as animals try to limit metabolic heat. Water consumption rises to compensate for sweating and panting. Heat stress disrupts hormones like growth hormone, cortisol, and thyroxine, affecting metabolism and productivity. Rumen function and digestion efficiency decline, leading to energy deficits, lower milk yield, and impaired reproduction. Chronic exposure affects liver function and fat metabolism, reducing overall fitness and lifespan.

Productivity and Economic Impact

Climate change reduces the quality and availability of pastures and forages, particularly during droughts, directly lowering meat and milk yields. Heat stress and poor nutrition increase disease susceptibility and reduce fertility, compromising herd recovery.

Animal Welfare and Management

Prolonged heatwaves, water scarcity, and poor housing degrade animal welfare. Mitigation strategies include providing shade, cooling systems, improved housing, and dietary adjustments, though implementation remains difficult in extensive grazing systems.

Disease and Pathogen Dynamics

Rising temperatures increase the prevalence of pathogens and parasites, leading to more disease outbreaks. Temperature and rainfall influence pasture availability and disease cycles (Lamy et al., 2012). Cold stress also increases morbidity and mortality (Mader, 2003). Increasing temperature and reduced rainfall degrade rangelands and lower feed conversion rates (Rowlinson, 2008).

Importance of Weather Forecasting in Livestock Rearing

Weather forecasting helps farmers manage livestock health, optimize feeding and grazing, minimize financial risks, and improve efficiency under variable weather conditions.

Key Benefits

- **Protecting Animal Health:** Enables timely preventive actions against heat stress, cold, and storms.
- **Optimizing Feeding and Grazing:** Supports smart grazing plans, feed storage, and spoilage prevention.
- **Managing Reproduction:** Allows better scheduling of breeding and birthing.
- **Reducing Financial Risks:** Improves planning for animal movement, insurance, and market operations.
- **Water and Resource Management:** Ensures efficient water and waste management.
- **Supporting Risk Planning:** Aids in validating insurance claims and risk assessments.

In summary, integrating weather forecasting into livestock management enhances animal welfare, operational efficiency, and resilience to climate variability.

CONCLUSION

Weather forecasting plays a vital role in sustainable livestock management by helping farmers anticipate and adapt to environmental changes. Accurate and timely forecasts allow for effective planning of shelter, feeding, breeding, and disease control strategies. Initiatives like Krishi Mausam Seva and the use of Automatic Weather Stations bridge the gap between meteorological science and farm-level decision-making. As climate change intensifies, integrating advanced forecasting tools and farmer training programs becomes essential for climate-smart animal husbandry.

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