# Title of the Project: Impact of Climate Change on Animal Husbandry Practices and Adaptation Strategies

## A Capstone Project Report submitted in partial fulfilment of the requirements for the award of the degree of,

**BACHELOR OF TECHNOLOGY IN**

**COMPUTER SCIENCE AND ENGINEERING**

## Submitted by:



| | |
|---|---|
| **SUNKU VENKATA SAI SHASHANK** | **BU21CSEN0101152 (TL)** |
| **PAMULURI CHANDRAMOULISWAR REDDY** | **BU21CSEN0101686** |
| **KONKA SAI KIRAN** | **BU21CSEN0100983** |
| **RAJANALA DHEERAJ SAI KUMAR REDDY** | **BU21CSEN0102009** |
| **A LIKHITESH KUMAR** | **BU21CSEN0100977** |

## Under the esteemed guidance of

## Dr. Chetana Tukkoji

## Assistant Professor

## Department of Computer Science and Engineering,

**GITAM SCHOOL OF TECHNOLOGY**

**GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT**

## (Deemed to be University)

## Bengaluru Campus.

**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

**GITAM SCHOOL OF TECHNOLOGY**

**GITAM**

**(Deemed to be University)**

# DECLARATION

We, hereby declare that the project report entitled "**Impact of Climate Change on Animal Husbandry Practices and Adaptation Strategies**" is an original work done in the **Department of Computer Science and Engineering, GITAM School of Technology, GITAM (Deemed to be University**), Bengaluru submitted in partial fulfilment of the requirements for the award of the degree of **B.Tech** in Computer Science and Engineering. The work has not been submitted to any other college or University for the award of any degree.

**Date:**

| | |
|---|---|
| **SUNKU VENKATA SAI SHASHANK** | **BU21CSEN0101152 (TL)** |
| **PAMULURI CHANDRAMOULISWAR REDDY** | **BU21CSEN0101686** |
| **KONKA SAI KIRAN** | **BU21CSEN0100983** |
| **RAJANALA DHEERAJ SAI KUMAR REDDY** | **BU21CSEN0102009** |
| **A LIKHITESH KUMAR** | **BU21CSEN0100977** |

**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

**GITAM SCHOOL OF TECHNOLOGY**

**GITAM**

**(Deemed to be University)**

# CERTIFICATE

This is to certify that the project report entitled “**Impact of Climate Change on Animal Husbandry Practices and Adaptation Strategies**” is a bonafide record of work carried out by **SUNKU VENKATA SAI SHASHANK (BU21CSEN0101152), PAMULURI CHANDRAMOULISWAR REDDY (BU21CSEN0101686), KONKA SAI KIRAN (BU21CSEN0100983), RAJANALA DHEERAJ SAI KUMAR REDDY (BU21CSEN0102009), A LIKHITESH KUMAR (BU21CSEN0100977),** submitted in partial fulfillment of requirement for the award of degree of Bachelors of Technology in Computer Science and Engineering.

| **Project Guide** | **Head of the Department** |
|---|---|
| **SIGNATURE OF THE GUIDE** | **SIGNATURE OF THE HoD** |
| **Dr. Chetana Tukkoji** | **Prof. Vamsidhar Yendapalli** |
| **Assistant Professor** | **Professor** |

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| | |
|---|---|
| **SUNKU VENKATA SAI SHASHANK** | **BU21CSEN0101152 (TL)** |
| **PAMULURI CHANDRAMOULISWAR REDDY** | **BU21CSEN0101686** |
| **KONKA SAI KIRAN** | **BU21CSEN0100983** |
| **RAJANALA DHEERAJ SAI KUMAR REDDY** | **BU21CSEN0102009** |
| **A LIKHITESH KUMAR** | **BU21CSEN0100977** |

# ABSTRACT

Livestock farming is becoming more challenging due to climate change, and finding the best locations to support different species is becoming increasingly important. The aim of the project is to develop a data-driven system that will recommend suitable habitats where various animal species can live safely. The system will use weather models and historical data to determine conditions such as temperature, humidity, precipitation, and other weather patterns. By understanding certain characteristics, it will be possible to recommend a geographic area where growth and health will be seen.

The system will provide detailed information on the suitability of the location as well as nutrition, shelter, and medical care. Specific recommendations will be provided on specific foods, seasonal adjustments, and strategies to protect animals from extreme temperatures. These include measures to prevent heat stress, influenza, infectious diseases, and water shortages. Farmers will be given feedback to improve animal survival and productivity. The program aims to create a sustainable agricultural system that helps farmers adapt to environmental change by integrating climate science into livestock management. It will support decisions to improve animal health and production.

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# 1. INTRODUCTION

In today's agriculture, climate change poses a major challenge for the livestock sector. Rising temperatures, changing rainfall patterns, and changing environmental conditions will affect animal health, production, and sustainability. To solve this problem, data-driven solutions are needed to adapt the livestock sector to climate change.

Traditional farming methods have difficulty accounting for many environmental factors, leading to inefficiency and risks for livestock farming. The project uses statistical data to determine the best locations for different livestock activities based on climate and environmental variables such as temperature, humidity, rainfall, soil quality, and vegetation. The system helps farmers reduce animal stress, increase productivity, and improve long-term sustainability by matching animals with suitable ecosystems. Integrating with existing farm management tools provides instant insights and recommendations to ensure livestock remains resilient in changing climates.

The project develops a method that performs climate and environmental analysis to determine the most suitable locations for raising different types of livestock.

The scope of this project includes:

1. Data Collection:
    - Gathering climate data (temperature, humidity, precipitation).
    - Acquiring environmental data (soil quality, vegetation patterns).
    - Compiling livestock-specific data to understand optimal conditions for various species.
2. Data Preprocessing:
    - Cleaning, formatting, and structuring data to ensure accuracy and consistency.
    - Removing outliers and inconsistencies for reliable analysis.
3. Data Analysis & Visualization:
    - Using machine learning and statistical techniques to assess environmental and livestock productivity correlations.
    - Generating visual tools like climate suitability maps and risk analysis reports to aid decision-making.

By combining these steps, the program helps farmers make informed decisions, reduce stress on animals, increase productivity, and ensure sustainability. The system can also be integrated with existing farm equipment to provide enhanced security protection.

# 2. LITERATURE SURVEY

A. Nardone, B. Ronchi, N. Lacetera, M.S. Ranieri, U. Bernabucci, “Effects of climate changes on animal production and sustainability of livestock systems.” [2010]: This paper reviews the Climate change impacts on livestock through increased droughts, reduced forage production, impaired growth, reproduction, and health, and lower adaptability in various systems. Desertification decreases rangeland capacity, while mixed and industrial systems face risks from grain variability. Optimizing crop productivity and enhancing animal resilience through management and selection are key strategies. Better data on biophysical and social vulnerabilities is essential for integrating livestock and agriculture in climate adaptation planning. [1]

JONATHAN R. MAWDSLEY, ROBIN O’MALLEY and DENNIS S. OJIMA, “A Review of Climate-Change Adaptation Strategies for Wildlife Management and Biodiversity Conservation.” [2009]: This paper reviews how climate change threatens species and ecosystems, prompting conservation efforts through adaptation strategies. A review of plans from multiple countries identified 16 strategies under four categories: land and water management, species management, monitoring, and policy. Existing conservation tools like restoration, translocation, and legislation remain relevant but require innovative applications to address emerging climate challenges effectively. Strengthening collaboration among policymakers, scientists, and local communities is crucial for successful implementation. Continuous research and adaptive management will enhance resilience in biodiversity conservation. [2]

Susanne C. Moser and Julia A. Ekstrom, “A framework to diagnose barriers to climate change adaptation.” [2010]: This article presents a systematic framework for identifying barriers to planned climate change adaptation. It structures adaptation into stages, examining obstacles in decision-making, governance, and exposure to climate risks. A diagnostic approach helps assess how actors, context, and systems contribute to barriers. The framework includes a matrix to pinpoint intervention points, offering a structured method to enhance adaptation efforts across different decision-making levels. Strengthening institutional capacity and fostering collaboration are key to overcoming these barriers. Implementing targeted interventions can improve adaptation effectiveness and resilience-building. [3]

William Solecki, Robin Leichenko and Karen O'Brien, "Climate change adaptation strategies and disaster risk reduction in cities." [2011]: This paper reviews the disaster risk reduction (DRR) and climate change adaptation (CCA) are increasingly interconnected in urban climate risk management. A review highlights key overlaps in hazard likelihood, vulnerability, and adaptive capacity, shaping how cities respond to climate risks. The integration of DRR and CCA is influencing research and practice, enhancing resilience in both developed and developing cities. Strengthening collaboration between researchers and practitioners is crucial for improving urban security and well-being. The potential for further synergy remains strong, driving innovative approaches to risk mitigation. [4]

Christopher B. Field and Vicente R. Barros "Climate Change – Impacts, Adaptation and Vulnerability: Regional Aspects." [2014]: This chapter introduces focusing on regional aspects of climate change, including impacts, adaptation, and vulnerability. It connects findings from physical climate science (WGI) and mitigation analysis (WGIII) to decision-making at various scales. The chapter synthesizes knowledge on regional climate changes, sectoral impacts, and decision-making approaches. It highlights regional similarities and differences, cross-regional issues, and methods for assessing vulnerabilities and adaptation. Strengthening research confidence and improving future scenario analyses are key objectives for enhancing climate-related decision-making globally. [5]

Charles W. Rice, "Climate Change: Impacts, Adaptation, and Mitigation." [2012]: This paper explains experience of rising temperatures, with fewer extreme highs in the short term but more in the long run, along with increased night time temperatures and greater variability. Annual precipitation is expected to rise by 10%, with wetter springs and drier summers, leading to more intense rainfall and runoff. Adaptation strategies include developing climate-resilient crops, improving irrigation and soil management, enhancing nitrogen efficiency, preventing soil erosion, and applying precision conservation techniques to sustain agricultural productivity. [6]

John Gaughan and A. J. Cawdell-Smith "Impact of Climate Change on Livestock Production and Reproduction." [2015]: This paper examines the impact of climate change on livestock performance, emphasizing the need for adaptation and mitigation strategies. It explores key factors such as physiological and genetic constraints that limit livestock adaptability to acute and chronic climate stress. The uncertainty surrounding climate change's effects on livestock, especially in developing countries, presents a significant challenge. Addressing these concerns requires improved breeding, management, and environmental modifications. Investing in climate-resilient livestock systems and sustainable resource use is crucial for maintaining food security and supporting smallholder farmers in a changing climate. [7]

Giampiero Grossi, Pietro Goglio, Andrea Vitali, and Adrian G Williams "Livestock and climate change: impact of livestock on climate and mitigation strategies." [2018]: This paper examines the impact of livestock production on climate change, emphasizing the need for mitigation strategies to reduce greenhouse gas emissions. It explores key emission sources such as methane from enteric fermentation and manure storage, along with nitrous oxide from fertilizers. With global population growth driving increased demand for livestock products, balancing food security with environmental sustainability is critical. Addressing emissions through improved management practices and technological innovations is essential. Strengthening research on low-emission livestock systems and promoting sustainable agricultural policies will support long-term climate resilience. [8]

NMB Nyoni, S Grab and ERM Archer, "Climate risk effects on rural poultry farming in low-income countries." [2019]: Rural poultry farming plays a crucial role in providing protein and income for resource-poor communities in developing countries. However, challenges such as slow growth, high mortality, poor nutrition, and disease susceptibility hinder production. Climate warming may further exacerbate these issues, increasing heat stress and production losses. This paper examines the impact of rising temperatures on rural poultry and highlights the need for targeted research. Developing adaptive management strategies is essential to ensure sustainable poultry production amid changing climate conditions. Improved housing, nutrition, and healthcare interventions can enhance resilience. Strengthening policies and farmer support systems will be critical for long-term sustainability. [9]

A. Nardone, "Effects of climate changes on animal production and sustainability of livestock systems." [2021]: The paper discusses the expected rise in animal production due to increasing global demand and how climate change will impact it. It highlights temperature and humidity variations, increased extreme weather events, and the challenges industrial and pasture-based livestock systems face. It explores techniques like Analysis of Temperature-Humidity Index (THI) trends in the Mediterranean region. Review of IPCC reports and climate projections. Evaluation of livestock system vulnerabilities based on existing research. The gap is a Lack of precise modelling and limited mitigation strategies. [10]

Mutlu Bulut Et Al, "Effects of Climate Change on Animal Husbandry" [2022]: This paper emphasizes the need for adaptation and mitigation strategies to sustain livestock systems amid changing climatic conditions. It explores technologies like Predictive Modelling and Comparative Analysis to assess impacts. However, a significant gap exists due to limited data on climate change's direct and indirect effects on different animal species, hindering effective policy and decision-making. Addressing this gap is crucial for developing resilient livestock systems and ensuring long-term sustainability. Investing in climate-resilient breeding programs and precision farming techniques can enhance adaptation efforts. [11]

Muxi Cheng Et Al, "The impact of climate change on livestock, covering effects on growth, reproduction, production" [2022]: This paper explores adaptation and mitigation strategies for managing livestock under climate stress, focusing on techniques like Animal Genetics, Physical Modifications, and Pest Management. However, a critical gap exists in advanced integrated pest management systems, which are essential for minimizing insecticide resistance. Addressing this challenge is crucial for enhancing livestock resilience, improving productivity, and ensuring long-term sustainability in the face of climate change. Developing climate-smart pest control methods and biological alternatives can reduce reliance on chemical treatments. Strengthening collaboration between researchers and farmers will drive the adoption of sustainable pest management strategies. [12]

Mutlu Bulut Et Al, "Effects of Climate Change On Animal Husbandry." [2023]: This paper highlights how agricultural practices contribute to greenhouse gas emissions and the need for sustainable approaches to mitigate these effects. It explores techniques like Data Analysis, Statistical Analysis, and Simulation Models. However, a key gap exists in data on emerging diseases, with limited research on how climate change will influence the spread of new livestock diseases, posing risks to animal health and productivity. Addressing this gap is crucial for developing effective disease management strategies. Strengthening surveillance systems and predictive modelling can help identify and control outbreaks early. Enhancing collaboration between researchers and policymakers is essential for proactive disease prevention. [13]

Sher Ali Jawhar Safi EL AL, "Impacts of Climate Change and Productivity on Animal Production." [2024]: Research, environmental modifications, genetics, and sustainable practices enhance livestock resilience. It explores techniques like Genetic Research, Holistic Approaches, and Environmental Modifications. However, a key gap exists in understanding the long-term adaptability of high-yield breeds to heat stress, which is essential for ensuring sustainable livestock production under changing climatic conditions. Integrating precision breeding and climate-smart feeding strategies can help mitigate these challenges. Advancing early-warning systems for heat stress will improve livestock health and productivity. Strengthening farmer education and policy frameworks is crucial for widespread adoption of resilience-building strategies. [14]

Youssef A. Attia, Ahmed K. Aldhalmi, Islam M. Youssef, Fulvia Bovera and Vincenzo Tufarelli “Climate change and its effects on poultry industry and sustainability.” [2024]:

This paper examines the impact of climate change on poultry production and the industry's role in greenhouse gas emissions. It explores key challenges such as increased water consumption, feed scarcity, and rising land demand, which threaten food security. The poultry sector's contribution to climate change underscores the need for targeted adaptation and mitigation strategies. Addressing these challenges requires region-specific measures and supportive policies. Investing in sustainable poultry farming is crucial for reducing emissions, enhancing food security, and ensuring long-term industry resilience amid climate variability. [15]

# 3. SOFTWARE AND HARDWARE SPECIFICATIONS

## 3.1 Introduction

This section outlines the project's specific requirements, including functional and non-functional needs. The focus is on ensuring that the necessary data and software tools are available and that the hardware is required to process and analyze the data.

## 3.2 Specific Requirements

### 3.2.1 Functional Requirement

The functional requirements define the core features and capabilities of the system. These include:

- Ability to retrieve and process climate data from NASA POWER-DAV and FAOSTAT databases.
- The system should be able to analyze and display animal data to identify patterns or trends.
- The system must provide insights and visualizations using Microsoft Excel and Microsoft Power BI.
- Data processing, analysis, and visualization must be done accurately and efficiently to provide relevant outputs for decision-making.
- User interaction with the system must be straightforward, with user-friendly interfaces for accessing climate and animal data.

### 3.2.2 Non-Functional Requirement

Non-functional requirements specify the performance and operational standards the system should meet. These include:

- Performance: The system should be able to handle large datasets from NASA POWER-DAV and FAOSTAT without significant lag or performance degradation.
- Scalability: The system should be scalable to accommodate growing data volumes and allow for the addition of new data sources or analytical features.
- Security: The system must ensure secure data access and storage, especially with sensitive environmental or animal data.

- Reliability: The system must operate without failure, with minimal downtime for maintenance and updates.
- Usability: The software tools and interfaces should be intuitive, allowing users to access and interpret data with minimal training.

### 3.3 Hardware and Software Requirements

#### 3.3.1 Hardware Requirement

The following hardware is required to run the system efficiently:

- Computer/Laptop: At least 8GB of RAM is required to ensure smooth operation and processing of large datasets.
- Storage: Sufficient storage space for handling climate and animal datasets, and for running applications like Microsoft Excel and Power BI.
- Processor: A modern multi-core processor to support the analysis and visualization tasks.
- Display: A screen with a resolution sufficient to display detailed data and charts, typically 1080p or higher.
- Internet Connectivity: A stable, high-speed internet connection to access remote databases such as NASA POWER-DAV and FAOSTAT.

#### 3.3.2 Software Requirement

The system should be able to run the following software:

- NASA POWER-DAV (Data Access Viewer): For accessing and retrieving climate data.
- FAOSTAT: For retrieving and analyzing animal and agricultural data.
- Microsoft Excel: For basic data manipulation, analysis, and organization of the datasets.
- Microsoft Power BI: For creating dashboards, visualizing the data, and generating reports for better insights and decision-making.

# 4. PROBLEM STATEMENT

## Impact of Climate Change on Animal Husbandry Practices and Adaptation Strategies.

As climate change continues to alter environmental conditions, livestock farmers face significant challenges in maintaining animal health, productivity, and overall farm sustainability. Rising temperatures, shifting precipitation patterns, and increased frequency of extreme weather events such as droughts and heatwaves contribute to increased stress on animals, leading to reduced milk yield, lower reproduction rates, and higher mortality. Additionally, fluctuations in humidity and wind patterns can increase susceptibility to diseases, disrupt feeding patterns, and reduce the availability of quality grazing land.

Beyond direct impacts on livestock, climate change also exacerbates environmental degradation. Unsustainable farming practices, coupled with climate-induced changes, can lead to habitat loss, soil erosion, water scarcity, and declining pasture quality. These challenges highlight the urgent need for adaptive strategies to ensure that animal husbandry remains viable and sustainable in the long term.

This project aims to address these pressing issues by developing a data-driven solution that integrates climate and environmental analysis to guide farmers in selecting suitable livestock breeds, optimizing farm management practices, and implementing preventative healthcare measures. By leveraging historical climate data and predictive analytics, farmers can make informed decisions to mitigate risks, improve animal welfare, and enhance resilience against climate variability. The ultimate goal is to promote sustainability in animal husbandry while ensuring economic viability for farmers.

4.1 Objectives:

- To analyze various climate parameters, such as temperature, precipitation, humidity, and wind patterns, to understand their trends and impacts on animal husbandry.
- To develop a predictive model that helps farmers understand and forecast the effects of different climate changes on their animals and farms.
- To identify livestock breeds that are more resilient to changing weather conditions, making them better suited for specific regions.

- To promote sustainable adaptation strategies by offering simple and practical recommendations for farmers to adjust their practices, ensuring the resilience and continuity of their animals and farms in the face of climate change.
- To foster awareness and education among farmers regarding climate-smart agricultural practices and encourage the adoption of environmentally friendly livestock management techniques.
- To support policy recommendations that enable climate-resilient livestock farming by integrating scientific research with local farming knowledge and regional climatic conditions.

By achieving these objectives, this project will contribute to a more sustainable and resilient livestock sector, ensuring food security, economic stability, and environmental conservation in the face of climate change.

# 5. System Architecture

5.1 System Architecture:

Modular Approach:

A data-driven system integrating climate and environmental factors to optimize livestock adaptation. The system analyses temperature, humidity, rainfall, soil quality, and vegetation patterns to identify suitable regions for different breeds, reducing stress and improving productivity.

Automation:

A correlation algorithm determines the impact of climate change on livestock, guiding breed selection and health interventions. If the correlation is negative, mitigation strategies like vaccinations or habitat modifications are recommended.

Testing & Validation:

Simulated environmental stress tests analyze the impact of climate fluctuations on livestock productivity. The system evaluates disease risks linked to changing climate conditions, such as increased tick or mosquito prevalence, and validates its predictive accuracy against real-world data.

Performance Optimization:

Continuous monitoring ensures real-time insights with minimal latency. The system integrates with agricultural and environmental management tools to enhance productivity, resilience, and sustainability, enabling data-driven decision-making for climate-resilient livestock farming.

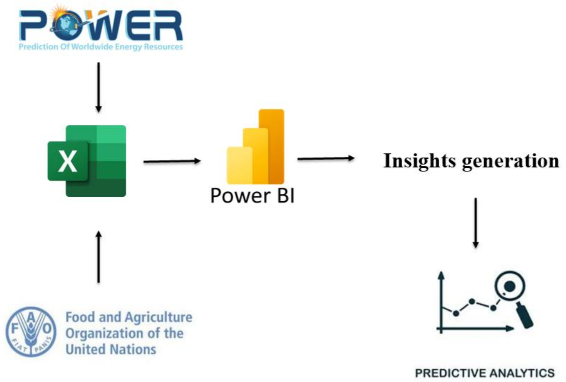


Figure 1: Design

5.2 Methodologies:

5.2.1 Climate Parameters:

User Community: Agro climatology

Temporal Level: Monthly & Annual

Temperature: Temperature at 2 Meters - Essential for assessing animal heat or cold stress.

Wet Bulb Temperature at 2 Meters - Helps understand the combined impact of humidity and temperature.

Earth Skin Temperature - Useful for understanding the effect of grazing conditions and heat stress on animals.

Humidity and Precipitation: Relative Humidity at 2 Meters - Indicates how moisture in the air affects livestock comfort.

Precipitation Average - Useful for assessing water availability and pasture growth.

Wind: Wind Speed at 2 Meters - Impacts animal comfort and management strategies.

Soil Properties: Root Zone Soil Wetness - Helps understand deeper soil moisture, which affects grazing and feed growth.

5.2.2 Algorithm:

Climate Change Impact on Poultry using Correlation Analysis

Step 1: Data Pre-processing

Collect climate data (temperature, humidity, etc.) and poultry production data (growth rate, egg production, etc.).

Normalize both datasets for consistency.

Align data points based on time intervals.

Step 2: Correlation Calculation

Compute the correlation coefficient (r) between climate variables and poultry production using Pearson or Spearman correlation.

If r > 0 (closer to 1), conclude that climate change does not impact poultry.

If r < 0 (closer to -1), conclude that climate change negatively impacts poultry.

Step 3: Decision Making

If r > 0 to 1, display: "Climate change does not significantly impact poultry."

If r is between 0 and -1, display: "Climate change negatively impacts poultry."

5.2.3 Dataset Description:

This project, Animal Husbandry Practices and Adaptation Strategies, utilizes data from NASA POWER-DAV and FAOSTAT to analyse climate impacts on livestock management. NASA POWER-DAV provides high-resolution climate data, including temperature, solar radiation, and precipitation, essential for assessing environmental stress on animals. FAOSTAT, maintained by the FAO, offers comprehensive statistics on livestock production, feed availability, and greenhouse gas emissions. By integrating these datasets, the project evaluates adaptation strategies, such as climate-resilient breeding, improved feeding systems, and sustainable resource management, to enhance livestock productivity under changing climatic conditions.

# 6. IMPLEMENTATION

Objective 1: Collect and pre-process climate and poultry data.

To ensure a robust and insightful analysis of the relationship between climate change and poultry production, a structured data collection and pre-processing pipeline was implemented. This phase involved sourcing relevant datasets, cleaning and formatting the data, integrating various sources, and preparing it for further analytical techniques.

Steps Involved:

- Data Sourcing: Retrieved historical and current climate data from NASA POWER-DAV, including temperature, humidity, and precipitation records. Poultry production data was sourced from FAOSTAT, covering metrics such as yield, mortality rate, feed conversion ratio, and production volume.
- Data Cleaning: Addressed missing values using statistical imputation techniques (e.g., mean/mode imputation for continuous variables) and removed duplicate records to ensure data integrity.
- Data Formatting: Standardized units (e.g., the temperature in Celsius, precipitation in millimeters) and converted categorical data into a numerical format where necessary for analysis.
- Data Integration: Merged climate and poultry datasets based on geographical and temporal identifiers to create a unified dataset for further analysis.
- Data Normalization: Scaled numeric values using Min-Max or Z-score normalization to maintain consistency across different variables and improve model performance.
- Preliminary Analysis: Conducted basic descriptive statistics to summarize data distribution, detect anomalies, and ensure readiness for advanced analytical techniques.

This structured approach ensured high-quality data for accurate climate-poultry relationship Analysis and adaptation strategy development.

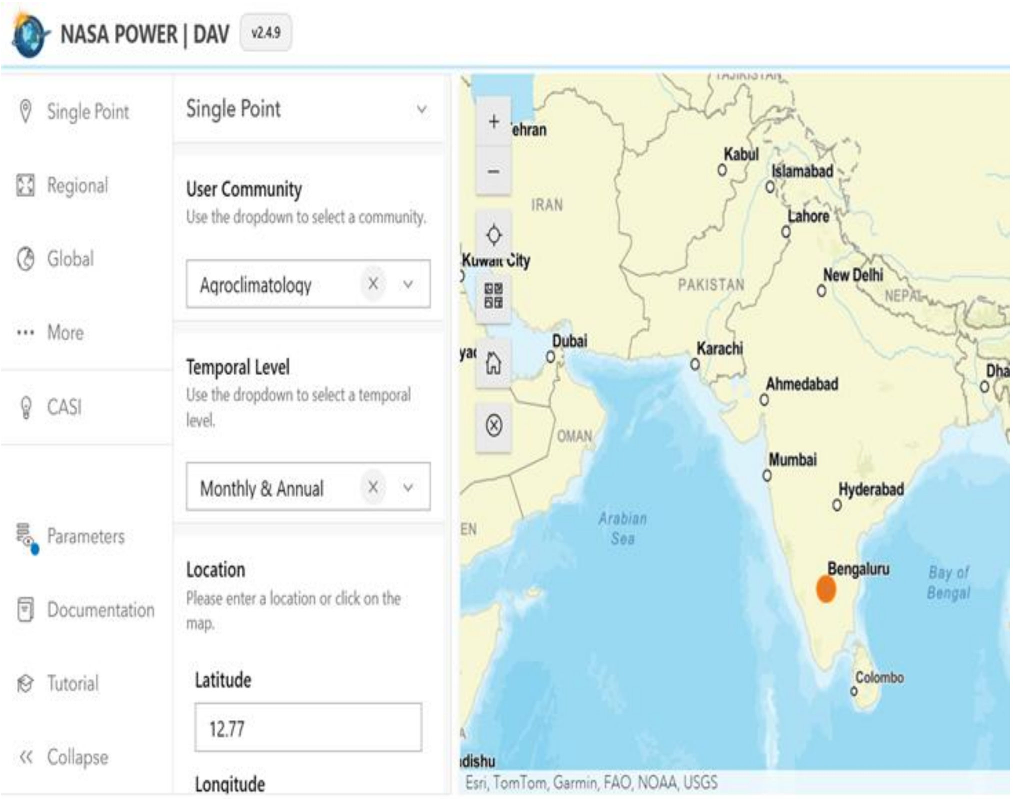


Figure 2: NASA POWER

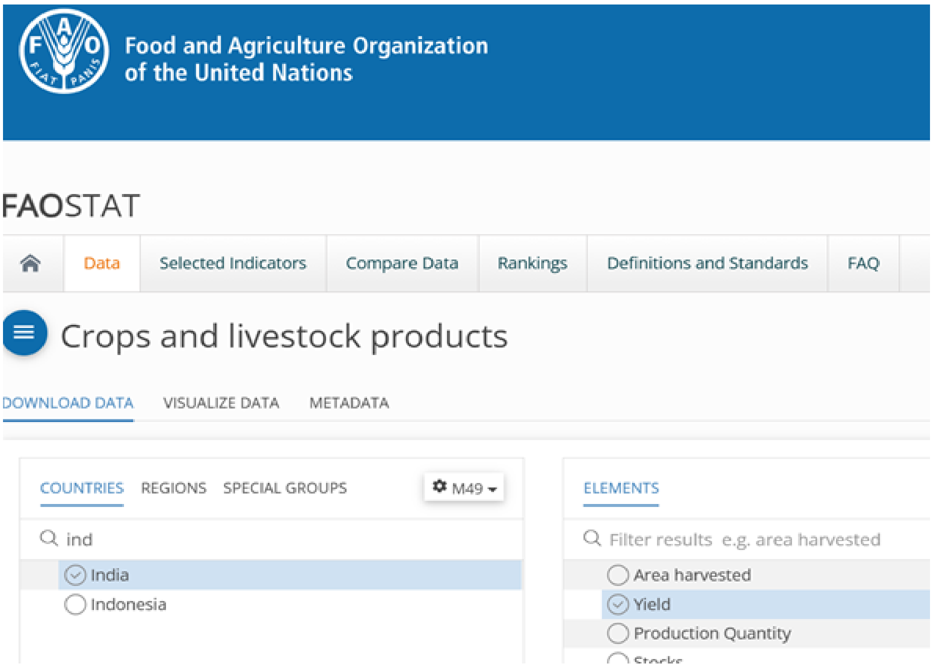


Figure 3: FAOSTAT

Objective 2: Analyze the relationship between climate factors and poultry production.

Methods Applied:

- Exploratory Data Analysis (EDA): Identified trends, patterns, and outliers in climate parameters (e.g., temperature, humidity, and precipitation) and poultry production metrics. Data visualization techniques such as histograms, box plots, and time-series graphs were used to detect anomalies and seasonal variations.
- Correlation Analysis: Examined statistical relationships between climate factors and poultry production using Pearson and Spearman correlation tests. This step helped determine whether variables like extreme temperature fluctuations or rainfall changes positively or negatively affect poultry yield, feed efficiency, and mortality rates.
- Statistical Significance Testing: Applied hypothesis testing (p-values and confidence intervals) to validate correlation strength and rule out spurious associations.
- Comparative Analysis with Historical Data: Compared current trends with past climate records to assess long-term impacts on poultry production.

These methods provided insights into how climate variability influences poultry farming, supporting the development of effective adaptation strategies.

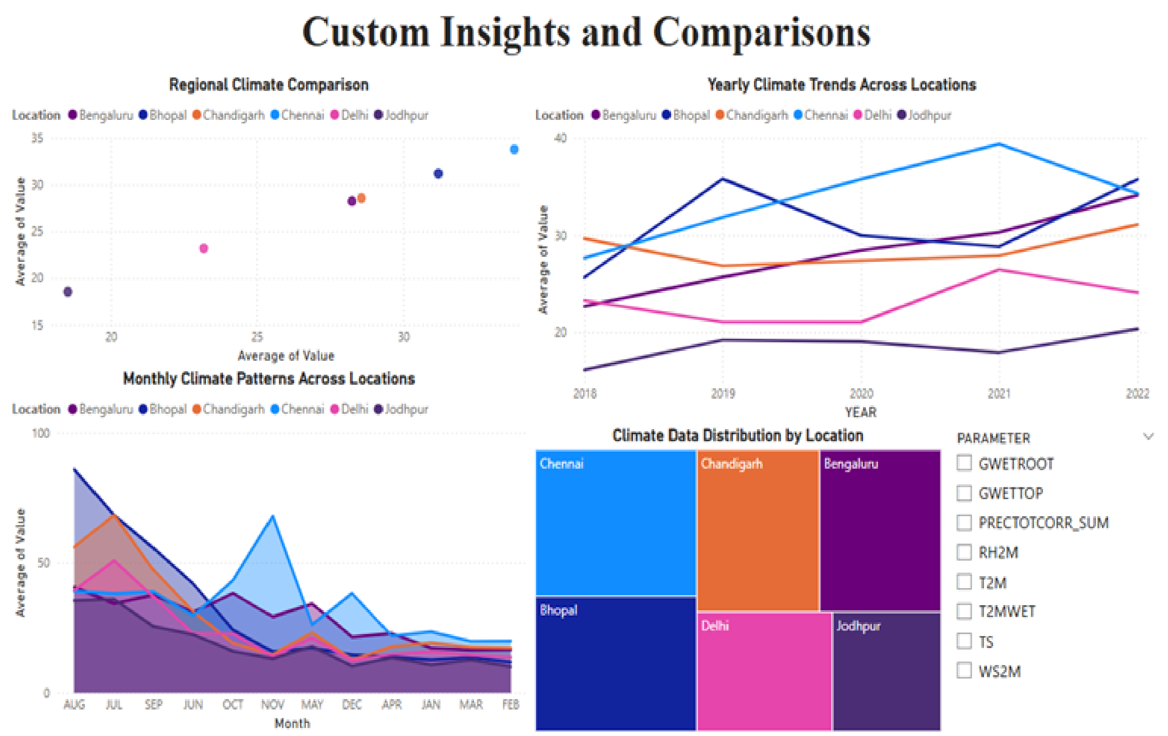


Figure 4: Insights and Comparisons

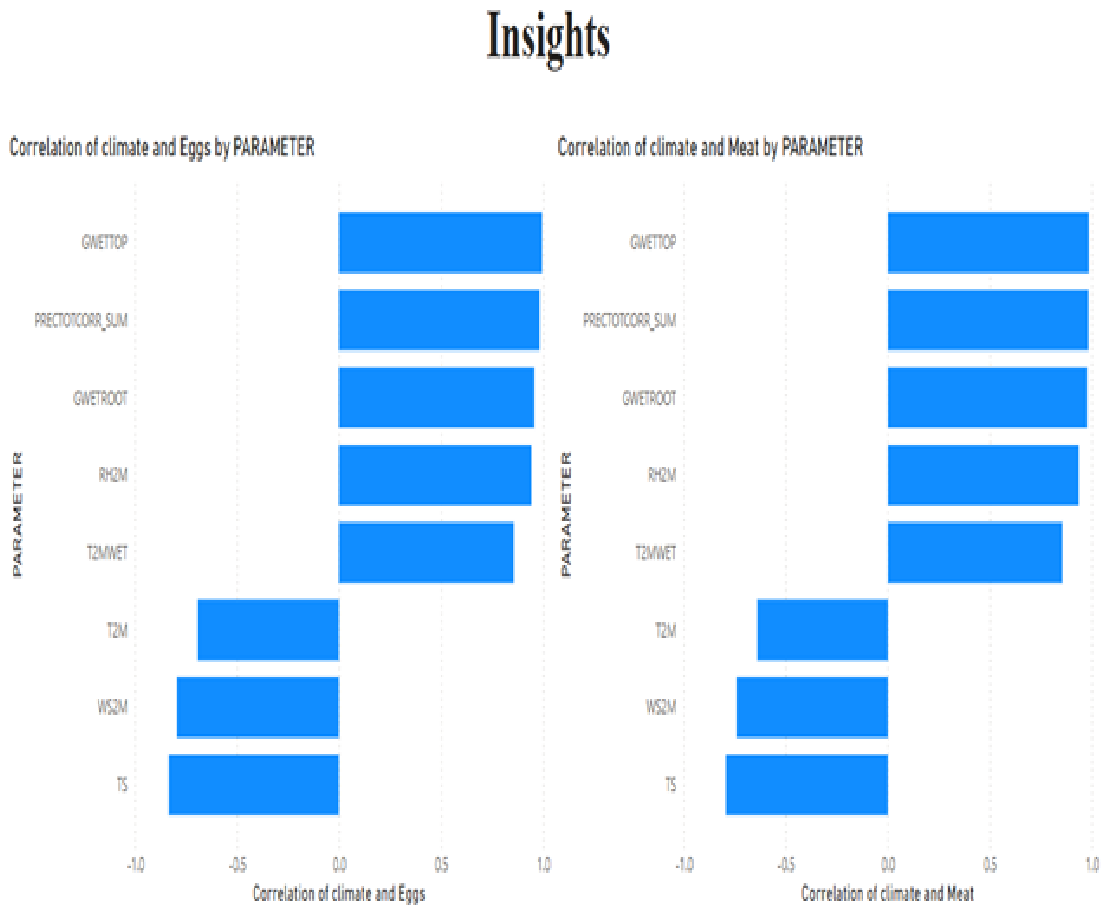


Figure 5: Insights

Objective 3: Visualize findings and generate insights for adaptation strategies.

Visualization Techniques:

- Line Charts & Bar Charts: Used to illustrate historical trends and year-over-year comparisons of climate factors (e.g., temperature, precipitation) and poultry production metrics (e.g., yield, mortality rates).
- Heat Maps: Applied to visualize correlation strength between climate parameters and poultry production, highlighting positive and negative relationships.
- Forecasting Charts: Implemented time-series forecasting models (e.g., ARIMA, Prophet) to predict future climate variations and their potential impact on poultry production.
- Tree Maps: Used for hierarchical visualization of poultry production across different regions, showing contributions by country or climate zone.

- Slicers & Interactive Dashboards: Integrated into visualization tools (e.g., Power BI, Tableau) to enable dynamic filtering of parameters, allowing users to explore different climate scenarios and their effects on poultry production.
- Box Plots & Violin Plots: Used to analyze data distribution, identify outliers, and assess climate variability's impact on poultry production trends.

These techniques provide comprehensive data exploration, enhancing decision-making and policy formulation for sustainable poultry farming under climate change.

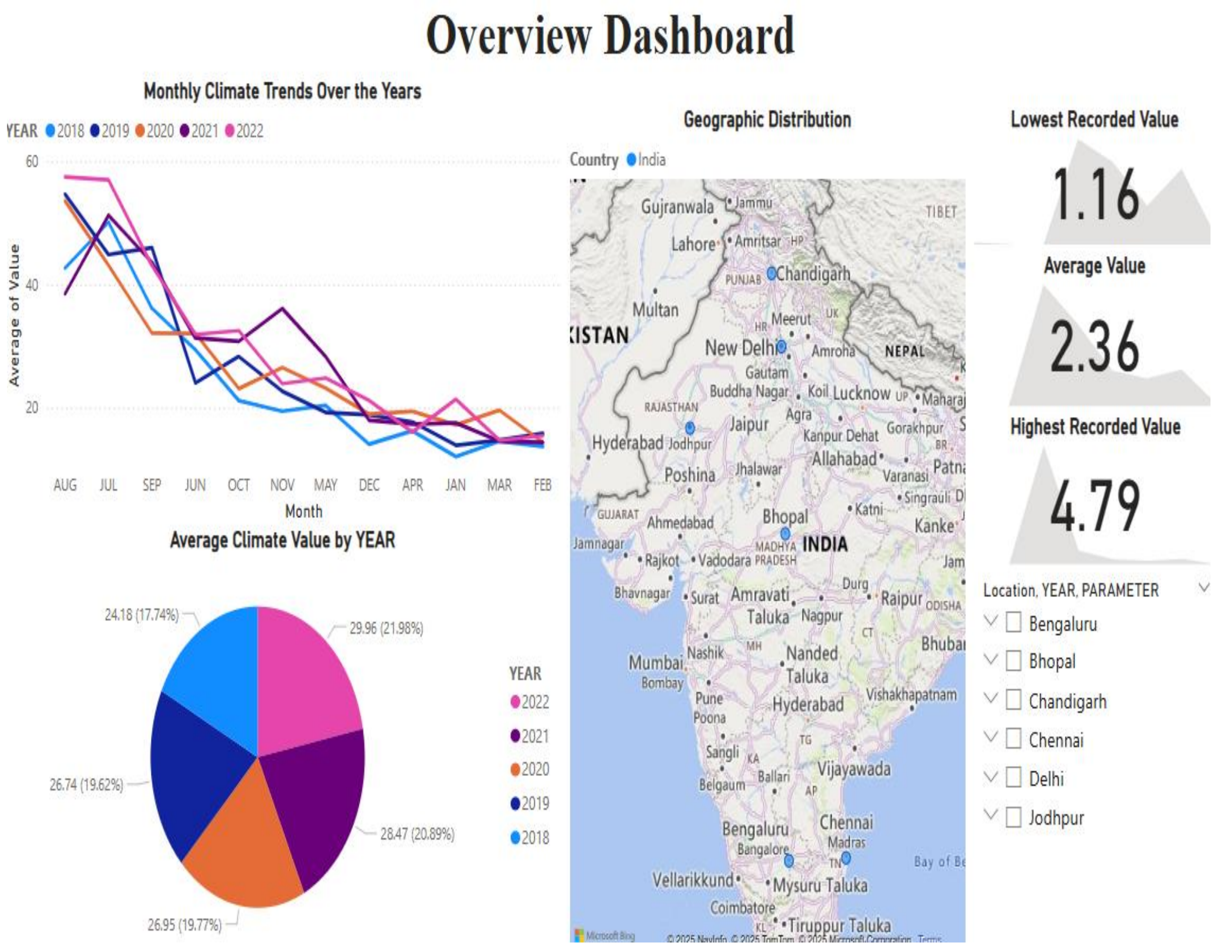


Figure 6: Dashboard

# 7. TESTING

## Correlation Testing for Climate and Poultry Production

Correlation testing was conducted to analyze the relationship between various climate parameters and poultry production metrics. The objective of this analysis was to determine how climatic factors influence poultry yield and productivity, providing a foundation for informed decision-making in poultry farming and adaptation strategies.

The correlation testing process involved the following steps:

- Correlation Calculation: Determining statistical relationships between climate variables and poultry yield was assessed using correlation coefficient. Positive and negative correlations were identified to determine how each climate parameter affects production.
- Validation of Correlation Results: Ensuring the reliability of correlation findings using statistical significance tests. Trends were compared across different time frames to account for seasonal variations and long-term climate trends.
- Parameter-Wise Testing: Individual climate factors were analyzed separately to isolate their specific influence on poultry production. Multi-variable regression analysis was performed to understand the combined effects of climate factors.
- Comparison with Predictive Trends: Observed correlations were compared with climate projections and industry forecasts to validate findings. Historical data trends were used to identify potential future risks and adaptive measures.

The results confirm that climate conditions significantly impact poultry production, providing insights into positive and negative influences on yield. These findings aid in developing informed adaptation strategies to mitigate climate-related risks.

Key observations include:

- Temperature Impact: High temperatures correlated negatively with poultry yield, leading to heat stress, reduced feed intake, and lower egg production. Extreme cold temperatures resulted in increased energy requirements for thermoregulation, affecting weight gain and feed efficiency.

- Humidity Influence: High humidity levels were associated with increased disease prevalence, particularly respiratory infections.
- Wind Speed: High wind speeds influenced ventilation and cooling strategies in poultry farms.
- Precipitation Effects: Excessive rainfall contributed to increased moisture levels in poultry housing, leading to higher ammonia levels and poor air quality.

# 8. EXPERIMENTAL RESULTS

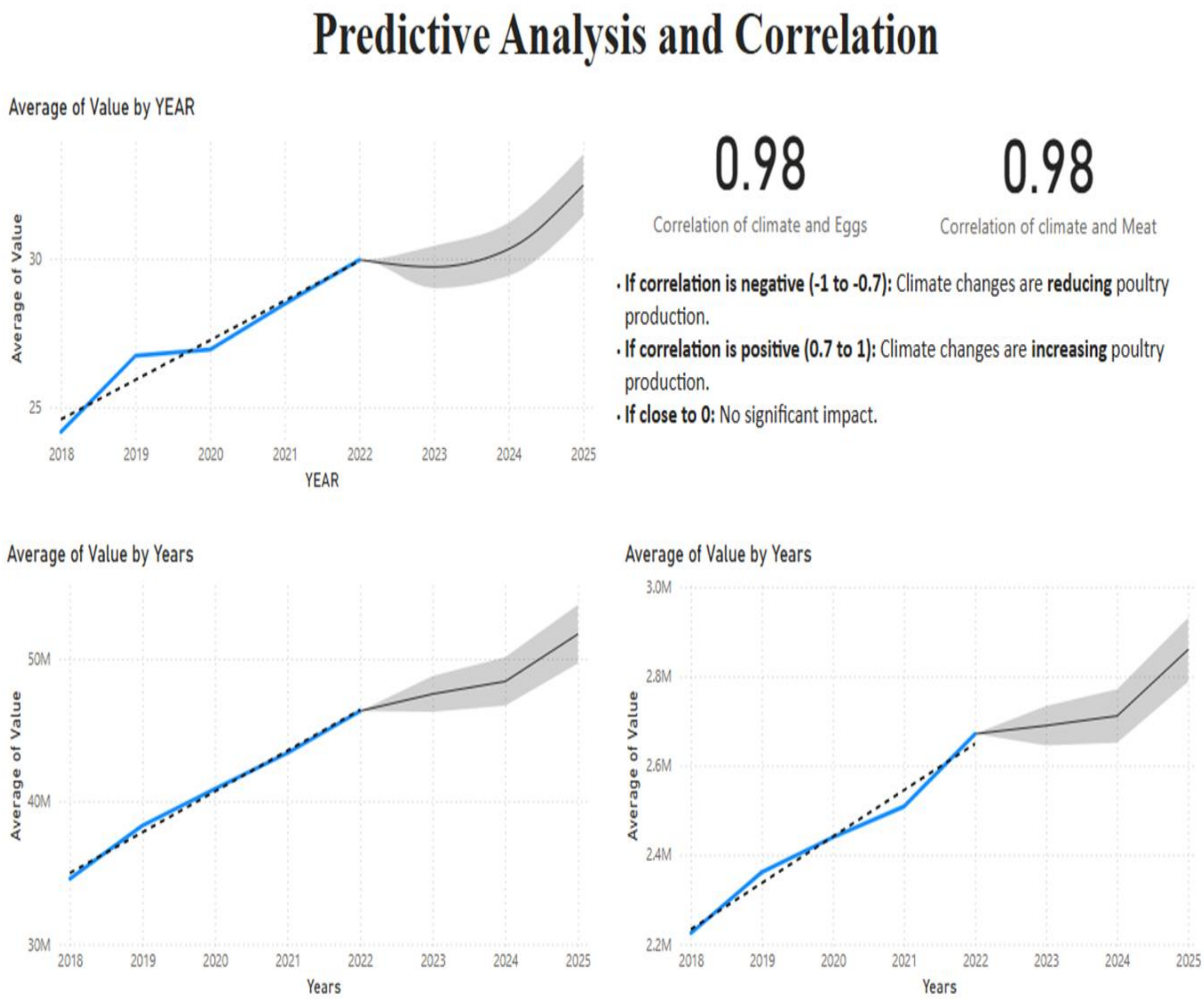


Figure 7: Predictive Analysis and Correlation

1. **Climate Trends & Predictive Analysis**: Future climate predictions align with historical trends, indicating consistent climate change patterns. Egg and meat production trends follow a similar trajectory, reinforcing the strong climate-poultry correlation.
2. **Strong Correlation Between Climate & Poultry Production:** A high correlation (0.98) between climate variables and poultry yield confirms that climate factors significantly influence egg and meat production. Trends indicate that climate variations impact poultry farming directly, necessitating adaptation strategies.
3. **Parameter-Wise Impact Analysis:**
   i. Positive Parameters (Enhancing Poultry Production):

- Relative Humidity at 2 Meters
- Wet Bulb Temperature at 2 Meters
- Surface Soil Wetness
- Root Zone Soil Wetness
- Precipitation Corrected Sum

ii. Negative Parameters (Affecting Poultry Production):

- Earth Skin Temperature
- Temperature at 2 Meters
- Wind Speed at 2 Meters

**Recommendations & Adaptation Strategies:**

1. To Maximize the Benefits of Positive Parameters
    - Maintain optimum humidity & temperature
    - Enhance Water Management
    - Soil Moisture Retention Strategies
2. To Mitigate Negative Impacts
    - Cooling Strategies for Heat Stress
    - Wind Barriers & Farm Orientation
    - Housing Modifications
    - Shade & Natural Cooling
    - Bedding & Floor Management

# 9. CONCLUSION

This project presents a comprehensive, data-driven approach to adapting animal husbandry practices in response to climate change. By leveraging climate data, predictive modeling, and advanced analytics, this study aims to equip farmers with actionable insights to optimize livestock management. Understanding how climate variables such as temperature, humidity, precipitation, and soil moisture impact different livestock breeds enables informed decision-making that enhances productivity and resilience.

Identifying optimal geographic locations for various livestock breeds ensures that animals are raised in environments best suited to their physiological needs. Additionally, tailored recommendations on diet, shelter, and healthcare provide farmers with effective adaptation strategies to mitigate climate-related risks. These strategies include optimizing feed composition to counteract the effects of extreme temperatures, designing climate-resilient housing structures, and implementing preventive healthcare measures to reduce the impact of climate-sensitive diseases.

Integrating historical climate data with predictive models allows for proactive risk management, enabling farmers to anticipate adverse conditions and take necessary precautions. This approach ensures that livestock can thrive despite environmental fluctuations, reducing economic losses and promoting long-term sustainability. By adopting precision farming techniques and leveraging climate-smart agricultural practices, farmers can enhance overall efficiency and minimize the negative impacts of climate variability.

Beyond individual farm-level benefits, this solution contributes to the long-term viability of the livestock sector by fostering sustainable farming practices. As climate change continues to pose challenges to global food security, data-driven solutions like this play a crucial role in safeguarding livestock production. By implementing evidence-based strategies, policymakers, researchers, and farmers can collectively build a more resilient and adaptive livestock industry, ensuring food security and economic stability in an era of increasing climate uncertainty.

# 10. PO'S ATTAINMENT

**Program Outcomes (POs)**

**PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems, reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

**PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.

**PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9. Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member and leader in a team to manage projects and in multidisciplinary environments.

**PO12.** **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

| Title of the Project: Impact of Climate Change on Animal Husbandry Practices and Adoption Strategies | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | | | √ | √ |

# 11. FUTURE WORK

Advanced Predictive Modelling:

- Develop machine learning models to enhance forecasting accuracy of climate impacts on poultry production.
- Integrate climate simulation models to predict long-term poultry yield variations.

Expanded Data Integration:

- Incorporate additional climate datasets to analyze future climate trends.
- Use remote sensing and IoT-based real-time climate monitoring for high-resolution data analysis.

Regional Adaptation Strategies:

- Conduct region-specific studies to tailor adaptation techniques for different climatic zones.
- Assess the effectiveness of sustainable poultry management practices under various climate scenarios.

Impact Assessment of Emerging Diseases:

- Investigate how climate variability influences the spread of poultry diseases and pathogens.
- Develop early warning systems for climate-driven disease outbreaks.

Policy and Economic Analysis:

- Evaluate the economic implications of climate change on poultry farming and food security.
- Develop policy recommendations to support climate-resilient poultry farming.

Sustainable Feed and Resource Management:

- Research alternative, climate-resilient feed sources to reduce reliance on water-intensive crops.
- Explore water conservation and heat stress mitigation strategies for poultry housing.

This future work will enhance poultry production resilience, improve predictive accuracy, and support informed decision-making for climate adaptation strategies.

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