Title: Utilizing Machine Learning for Predicting Milk Production in New Zealand Based on Climate Factors

Abstract

The agricultural sector's sustainability, particularly dairy farming in New Zealand, is significantly influenced by climate conditions. This research employs machine learning (ML) techniques to predict milk production, utilizing variables such as rainfall, temperature, humidity, and sunshine duration. The study aims to develop a predictive model that enhances decision-making and resilience in dairy farming against the backdrop of climate change. By integrating historical climate and production data, this research not only seeks to improve operational efficiencies but also to contribute to the academic discourse on applying ML in agriculture.

1. Research Background

1.1 Introduction to Dairy Farming in New Zealand

New Zealand is a premier dairy producing country, contributing significantly to the global dairy market. The interdependence between dairy farming and climatic conditions is well-documented, highlighting the sector's vulnerability to climate variability. The nation's economy and the global food chain heavily rely on the stability and productivity of its dairy industry (Statistics New Zealand, 2020).

1.2 The Impact of Climate on Dairy Production

Climate factors such as rainfall, temperature, and sunshine play a crucial role in pasture-based dairy farming, directly influencing milk yield and quality. Variations in these factors can lead to significant fluctuations in production, challenging the sector's sustainability (FAO, 2018).

2. State of Research

2.1 Traditional Methods in Agricultural Forecasting

Traditional forecasting methods in agriculture have predominantly relied on statistical models and historical trends. However, these approaches often fall short in capturing the complex dynamics between climatic variables and milk production (Jones et al., 2017).

2.2 Advancements in Machine Learning for Agriculture

Recent advancements in ML and data analytics have opened new pathways for predicting agricultural outcomes. ML models are adept at handling complex, nonlinear relationships between multiple variables, offering a more nuanced understanding of the factors affecting dairy production (Smith & Marshall, 2019).

3. Models and Methods

3.1 Data Collection and Preprocessing

This study will utilize historical data from various sources, including the National Institute of Water and Atmospheric Research (NIWA) and DairyNZ. The data will undergo rigorous preprocessing to ensure accuracy and consistency (NIWA, 2020; DairyNZ, 2021).

3.2 Model Selection

A comparative analysis of several ML models, including linear regression, decision trees, and neural networks, will be conducted. The selection criteria will be based on predictive accuracy, with a focus on minimizing error metrics such as MAE and RMSE (Hyndman & Athanasopoulos, 2018).

3.3 Validation and Testing

The model's performance will be validated using a split of training and test data, supplemented by cross-validation techniques to assess its generalizability across different climatic and production conditions (Kohavi, 1995).

4. Research Value

4.1 Implications for Dairy Farming

The development of a reliable ML-based predictive model for milk production has the potential to transform dairy farming practices, enabling farmers to make informed decisions and optimize production processes in the face of climate variability (FAO, 2021).

4.2 Contributions to Agricultural Research

This research aims to contribute to the broader application of ML in agriculture, providing a methodological framework that can be adapted to other contexts and promoting data-driven decision-making in the sector (Liakos et al., 2018).

References

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