**Enhancing Crop Yield Prediction and Rainfall Forecasting in Kitui County Using Machine Learning**

**Abstract**

Agriculture in Kitui County, Kenya, is highly vulnerable to climate variability, characterized by erratic rainfall patterns and declining soil fertility. This study explores the application of machine learning techniques to enhance crop yield prediction and rainfall forecasting, thereby supporting data-driven agricultural decision-making. Historical data from 2000 to 2024, sourced from the Kenya Meteorological Department, the Kenya National Bureau of Statistics (KNBS), and NASA EarthData, were analyzed to assess rainfall trends, soil quality, and crop yields. Random Forest Regression and XGBoost were employed for crop yield prediction, achieving R-squared values of 0.82 and 0.87 respectively. For rainfall forecasting, ARIMA and Recurrent Neural Networks (RNNs) yielded forecasting accuracies of 78% and 84% respectively. Findings indicate a 10–15% projected decline in rainfall by 2035, increasing drought risks, while crop yield analysis highlights the resilience of drought-tolerant crops such as sorghum and pigeon peas. The study recommends the adoption of climate-resilient crops, AI-driven smart irrigation systems, and early warning mechanisms to mitigate agricultural risks. By integrating machine learning into agricultural planning, this research provides actionable insights that can enhance food security and sustainable farming in Kitui County. Future research should explore deep learning techniques and real-time sensor integration for improved predictive accuracy.  
  
Keywords: Crop yield prediction, rainfall forecasting, machine learning, Random Forest, XGBoost, ARIMA, RNN, Kitui County, climate resilience, food security