

Agro Guard: A Smart IoT and Machine Learning-Based Assistant for Climate-Resilient Precision Agriculture

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Abstract

Agriculture plays a vital role in ensuring global food security amid growing population pressures. However, climate change, soil degradation, and natural disasters such as floods pose serious challenges to maintaining soil health and optimizing crop productivity. This paper presents Agro Guard, a smart agriculture assistant that leverages wireless IoT soil sensors, machine learning, and robust data management to support climate-resilient precision farming. The system integrates real-time monitoring of critical soil parameters (moisture, temperature, nitrogen, phosphorus, and potassium levels) with a Random Forest Classifier trained on a dataset of over 2,000 samples sourced from Kaggle. This dataset includes soil nutrient profiles and crop yield records, enabling the model to recommend optimal crops tailored to specific soil conditions. The system's interactive web dashboard, built on the Flask framework, provides dynamic visualization, crop-specific fertilization, and irrigation scheduling. Quantitative evaluation of the model shows an accuracy exceeding 85% in crop recommendation tasks, demonstrating reliable performance. Agro Guard also offers targeted post-flood soil recovery strategies to restore land productivity effectively. While field validation across diverse agro-climatic zones is ongoing, the system shows promise in enhancing resource efficiency and farmer decision-making. Future work includes incorporating digital image processing (DIP) to improve precision and AI-based voice assistance for greater accessibility. Overall, Agro Guard delivers a data-driven, scalable solution to promote sustainable and climate-resilient agriculture.

Keywords: IoT Sensors, Machine Learning, Precision Agriculture, Soil Analysis, Crop Recommendation