

Precision Agriculture Using IoT and Machine Learning: A Review with a Focus on Indian Agriculture

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Abstract: *This review article outlines a proposed precision agriculture system designed to empower smallholder farmers in sustainable agricultural activities, particularly within the context of Indian agriculture. Addressing critical challenges such as climate change vulnerability and inefficient resource management, the system integrates Internet of Things sensors, advanced machine learning models, and user-centric interfaces. The architecture features a layered approach, including an IoT Sensing Layer with low-cost sensors and robust connectivity (LoRaWAN/4G), a cloud-based Analytics Layer employing Python-based ML pipelines for irrigation prediction (RL/LSTMs), fertilizer recommendation (MORF/SVM), disease risk assessment, and yield forecasting (Regression/RF), and an accessible Interface Layer with a Flutter-based hybrid mobile-web app featuring a multilingual voice-to-text chatbot. As a partially implemented framework, core functionalities like IoT data collection and preliminary ML models have been demonstrated in a simulated environment using open-source software and mock/Kaggle datasets, achieving promising results with model accuracy ranging from 82%-94%. This iterative development approach allows for continuous refinement, with future work focused on real-field demonstrations in climate-vulnerable regions such as Maharashtra and Punjab. The methodology emphasizes scalability, affordability, and alignment with sustainable development goals, promising increased resilience and optimized resource utilization for smallholder farming communities.*

Keywords: Precision Agriculture, Internet of Things, Machine Learning, Smallholder Farmers, Sustainable Agriculture, Artificial Intelligence, Agricultural Technology, India, Crop Management, Resource Optimization

