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A Review of Integrated CNN and ML Models for Crop Disease Diagnosis, Soil-Nutrient-Based Crop Selection, and Yield Forecasting

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Abstract: *Recent advancements in artificial intelligence have led to significant progress in agricultural automation, particularly in the areas of crop disease detection, crop recommendation, and yield prediction. This review paper examines the development of integrated systems that combine deep learning and machine learning to support data-driven decision-making in farming. A detailed analysis is presented on Convolutional Neural Networks (CNNs) used for identifying diseases from leaf images, as well as machine learning models that utilize soil nutrient values—specifically nitrogen, phosphorus, and potassium (NPK)—along with climatic factors to recommend suitable crops. The study also reviews current regression-based approaches for estimating crop yield using environmental, soil, and plant-related parameters. Existing research, methodologies, datasets, performance trends, strengths, and limitations of these approaches are summarized to provide a unified understanding of the field. The review highlights the increasing need for integrated frameworks that combine image-based diagnostics and soil-nutrient analysis to improve crop productivity. Future directions emphasize robustness in real-world conditions, localized datasets, and scalable intelligent systems for precision agriculture.*

Keywords: Deep Learning, Machine Learning, Crop Disease Detection, CNN, NPK Analysis, Crop Recommendation, Yield Prediction, Smart Agriculture, Precision Farming, Agricultural Decision Support Systems

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