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ARTIFICIAL INTELLIGENCE FOR CROP DISEASE PREDICTION

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ABSTRACT

Artificial Intelligence (AI) is transforming modern agriculture by improving crop productivity and disease management. Traditional disease detection methods are often time-consuming and less accurate, leading to yield losses. AI technologies, including Machine Learning (ML), Deep Learning (DL), Convolutional Neural Networks (CNN), and image processing, enable rapid and precise disease detection using leaf images, environmental data, and crop information. These tools support precision agriculture by optimizing pesticide use, enhancing crop monitoring, and improving decision-making. Integrating AI with drones, IoT devices, and mobile applications can further strengthen sustainable agriculture, climate resilience, and global food security..

KEYWORDS: Artificial intelligence, crop disease prediction, deep learning, machine learning, precision agriculture

INTRODUCTION

Agriculture plays a vital role in global food security and economic development. Increasing population growth and climate change have created pressure on agricultural systems to improve crop productivity and quality. Crop diseases significantly affect agricultural yield and can lead to severe economic losses for farmers. Traditional disease detection methods depend on manual observation and expert knowledge, which may be slow and inaccurate.

Artificial Intelligence (AI) has introduced advanced solutions for smart farming and crop disease prediction. AI techniques such as machine learning, deep learning, and image processing help farmers identify plant diseases at early stages using leaf images and environmental data. Smart farming technologies improve crop monitoring, reduce labour requirements, and enhance agricultural productivity. AI-based systems can also assist in disease classification, yield prediction, irrigation management, and pesticide optimization (Akkem et al., 2023).

AI TECHNIQUES USED IN CROP DISEASE PREDICTION

Machine Learning (ML) and Deep Learning (DL) are widely used in agricultural disease prediction systems. Machine learning algorithms such as Support Vector Machine (SVM), Random Forest, and Decision Tree are applied for disease classification and crop monitoring. These algorithms analyse crop features, environmental conditions, and image datasets to identify disease patterns.

Deep Learning techniques, especially Convolutional Neural Networks (CNN), have shown high accuracy in detecting crop diseases from leaf images. CNN models automatically extract image features and classify infected regions with greater efficiency than traditional methods. Researchers have used CNN-based systems for detecting diseases in tomato, rice, banana, and grape crops. Smartphone-assisted disease diagnosis systems also help farmers identify crop diseases in real-time (Chen et al., 2022).

Image processing techniques are commonly integrated with AI systems to improve disease recognition. These methods involve image segmentation, feature extraction, and classification. Advanced technologies such as drones, sensors, and IoT devices further support disease monitoring and precision agriculture.

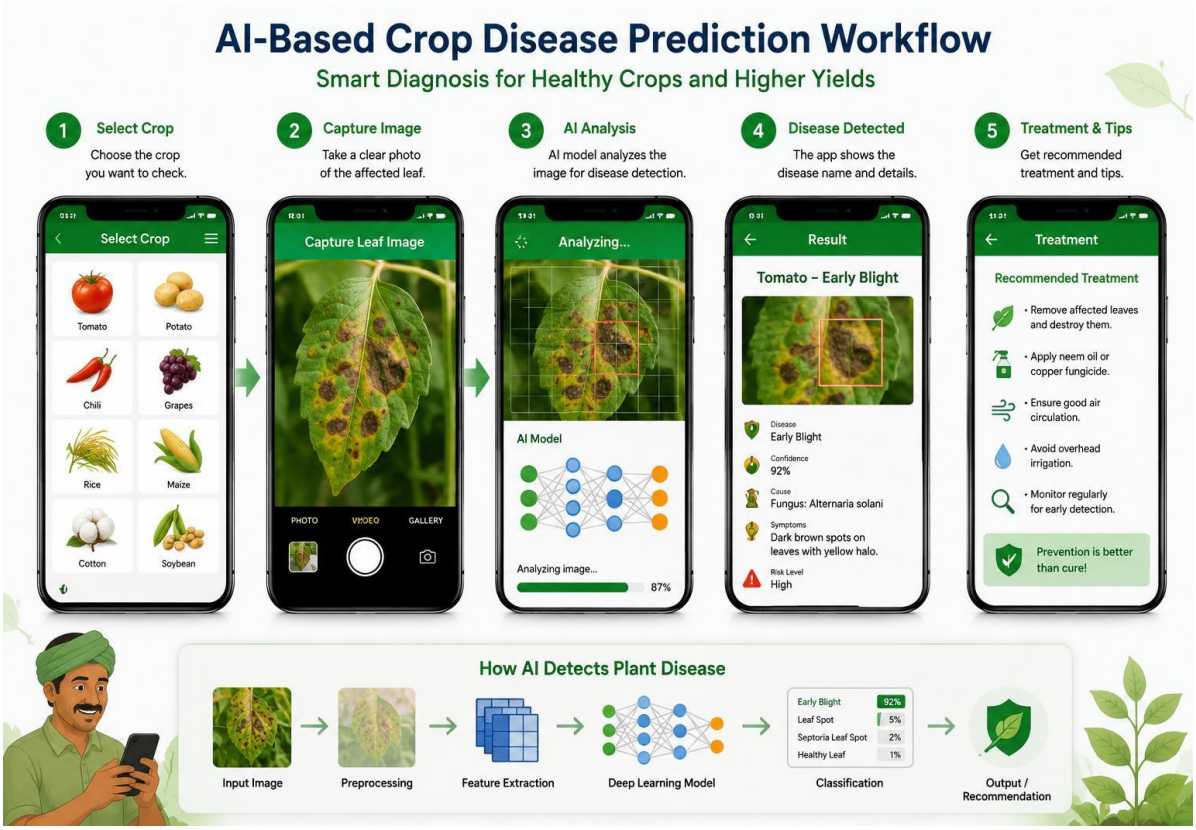

Figure 1. AI-Based Crop Disease Prediction Workflow

APPLICATIONS OF AI IN AGRICULTURE

AI-based crop disease prediction systems are used in various agricultural applications. Disease detection models can identify leaf infections, pest attacks, and nutrient deficiencies with high accuracy. AI technologies support precision farming by reducing excessive pesticide usage and improving crop health management

Machine vision and drone technologies are used for large-scale crop monitoring and disease surveillance. Sensors can collect environmental data such as soil moisture, humidity, and temperature, which are analysed using AI algorithms for predictive farming. AI also assists farmers in irrigation management, yield prediction, and smart greenhouse systems. The use of AI in agriculture improves productivity, reduces labour costs, and supports sustainable farming practices. Smart farming technologies provide efficient decision-making systems that help farmers respond quickly to crop health issues (Kashyap et al., 2024).

CHALLENGES AND FUTURE SCOPE

Although AI provides significant benefits in agriculture, several challenges remain. High implementation costs, limited internet access, and insufficient agricultural datasets restrict the adoption of AI technologies in rural areas. Environmental variations and poor image quality may also affect prediction accuracy.

Future developments in AI-based agriculture are expected to focus on affordable mobile applications, automated drones, and real-time disease monitoring systems. Integration of AI with IoT and cloud computing can improve smart farming efficiency. AI-supported agriculture may play an important role in ensuring food security and climate-resilient farming systems (Sampatirao et al., 2026).

CONCLUSION

Artificial Intelligence has become an important tool for crop disease prediction and smart farming. AI techniques such as Machine Learning, Deep Learning, and CNN provide accurate and efficient disease detection systems. These technologies improve agricultural productivity, reduce crop losses, and support sustainable farming practices. Although challenges such as infrastructure cost and data availability still exist, future AI innovations can transform modern agriculture and strengthen global food security.

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