PhD Research Proposal

Title: AI-Driven Decision Support System for Smart Agriculture in Rural India

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1. Introduction

Agriculture remains a cornerstone of the Indian economy, particularly in rural areas. However, traditional farming methods are increasingly challenged by unpredictable climate patterns, resource scarcity, and pests. Smart agriculture—powered by Artificial Intelligence (AI)—offers scalable solutions by enabling data-driven decision-making for crop management, irrigation, disease prediction, and yield optimization.

Kalasalingam Academy of Research and Education (KARE), with its focus on applied research for social impact, provides an ideal platform for building AI systems that directly benefit rural communities. This proposal aims to design an AI-based decision support framework tailored to small and medium-scale farmers, integrating real-time sensor data, remote sensing, and predictive modeling.

2. Research Problem

Despite technological advances, most AI-based agricultural systems are designed for high-resource environments and are often inaccessible to smallholder farmers. Key challenges include:

- Lack of localized models for region-specific crops.

- Limited connectivity and infrastructure in rural regions.

- Insufficient integration of real-time data from low-cost IoT sensors and satellite imagery.

3. Objectives

- To develop AI models for early pest detection, yield forecasting, and irrigation planning using minimal resources.

- To integrate data from remote sensing (satellite/drone imagery) and ground-based IoT sensors.

- To create an easy-to-use decision support system (DSS) for non-technical users, available in regional languages.

- To validate the system through pilot testing in selected rural communities.

4. Research Questions

1. How can AI models be optimized for local crop varieties using limited data?

2. What is the optimal way to combine multisource data (satellite, sensor, weather) for actionable insights?

3. How can a decision support system be designed for farmers with low digital literacy?

5. Methodology

- Data Collection: Collaborate with agricultural agencies and use open-access satellite data (e.g., Sentinel-2, Landsat), weather APIs, and IoT devices (e.g., soil moisture, temperature sensors).

- Model Development:

  - Use deep learning (e.g., CNNs, RNNs) for crop health monitoring from images.

  - Apply machine learning models (e.g., Random Forest, Gradient Boosting) for yield forecasting and irrigation scheduling.

- System Design: Build a mobile/web DSS with visual analytics and regional language support.

- Field Validation: Deploy the system in one or more agricultural sites for real-world testing.

6. Expected Outcomes

- A lightweight, field-deployable AI framework for smart farming in resource-limited settings.

- An intelligent DSS co-developed with farmers for usability and trust.

- Academic contributions in AI, HCI, and agricultural informatics.

- Scalable model for government or NGO partnerships in rural development.

7. Timeline (3–4 years)

- Year 1: Literature review, problem scoping, initial data collection.

- Year 2: AI model development, begin DSS design.

- Year 3: Integrate models into system, pilot testing in rural areas.

- Year 4: Performance evaluation, final framework design, publish findings.

8. References

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