Project Proposal

TIH - IoT CHANAKYA Fellowship

Program 2025

Image-based Disease Detection leveraging Machine Learning Approaches for the crops (Rice, Wheat, Sugarcane, Maize and Cotton)

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Executive Summary

Rice and Cotton. The system will empower farmers with a mobile application for rapid, image-based disease detection, using models selected from a rigorous comparison of state-of-the-art architectures. Its core innovation is a **hybrid IoT/cloud architecture**; a **lightweight TensorFlow Lite** model **runs offline for instant analysis**, while a more powerful **cloud-based model** provides higher-accuracy diagnoses when internet is available. To foster user trust, the system incorporates **explainable AI (XAI) using Grad-CAM heatmaps**. With support for multiple regional Indian languages, the application will provide a fast, reliable, and accessible tool to help reduce yield loss and promote sustainable agricultural practices. This project will deliver a validated prototype within the fellowship timeframe, contributing to food security and economic growth.

1 Background

Agriculture is a cornerstone of India's economy, with rice and cotton being two of the most vital crops for food security and economic stability. Both crops have historically been vulnerable to diseases that significantly reduce yield and quality, threatening farmer livelihoods. Rice is severely affected by diseases like Rice Blast, which causes destructive lesions, and Bacterial Blight, leading to widespread wilting and grain loss. Similarly, cotton, a critical cash crop, faces major challenges from Cotton Leaf Curl Virus, which stunts plant growth, and Boll Rot, which directly damages the valuable bolls.

Traditionally, disease identification has relied on manual inspection, a process that is slow, costly, and prone to error, especially during the early stages. This delay in accurate detection often leads to devastating losses. However, the recent proliferation of smartphones combined with advancements in machine learning now presents a transformative opportunity to create automated, low-cost diagnostic tools. These tools can empower farmers with the timely information needed for more sustainable and productive farming.

2 Statement of the problem

Rice and Cotton crops suffer significant yield losses from diseases due to slow and inaccurate manual detection methods. This diagnostic delay prevents timely and effective intervention. While academic research has explored deep learning for this task, existing solutions often lack the robust offline capabilities and farmer-centric design needed for practical field deployment. The core problem is the absence of a scalable, low-cost mobile system that bridges this gap, providing farmers with an immediate and accurate on-field diagnostic tool to improve productivity and sustainability.

3 Objectives

The primary objective is to design and deploy a robust, image-based disease detection system for Rice and Cotton. The project aims to achieve the following SMART objectives within the fellowship timeline:

- Develop and compare advanced ML models (CNN, Transfer Learning, ViT) to select the most accurate architectures.
- Implement a hybrid diagnostic system, featuring a lightweight offline model for on-device use and a high-accuracy online model.
- Integrate explainable AI (Grad-CAM) to provide transparent visual diagnoses.
- Deploy the system as a multi-language mobile prototype and validate it to achieve ≥90% classification accuracy.

4 Deliverables

The project will produce the following key deliverables:

- A comparative evaluation report and the final trained models, including a lightweight .tflite version for offline use and a high-accuracy model prepared for cloud deployment.
- A functional, multi-language mobile prototype application with an integrated explainable AI (Grad-CAM) module for transparent visual diagnosis.
- A final validation report quantifying the system's performance, targeting an accuracy of ≥90%, with detailed precision and recall metrics.
- Complete system documentation and usage guidelines.

5 Project Plan with Major Milestones

Sr. No.	Milestone	Target Date	Remarks
1	Phase 1: Foundation & Data Preparation	November 30, 2025	Analyze, pre-process, and augment the provided dataset to create a high-quality foundation for training multiple advanced models.
2	Phase 2: Core Model Development & Comparative Evaluation	31st Mar 2026	For each crop, develop and compare three architectures: a custom CNN, Transfer Learning, and a Vision Transformer. The best models for deployment will be selected.
3	Phase 3: Hybrid System & XAI Development	31st May 2026	Develop the TensorFlow Lite model for offline use and deploy the high-accuracy model on a cloud server. Build the logic for the Grad-CAM visualizations.

4	Phase4: Application, Integration & Validation	31st Jul 2026	Develop the mobile app UI with multi-language support. Integrate all features and conduct final field testing and reporting to validate system performance.

6 Resources and budget

The total estimated budget for this project is approximately **₹23,100**. The project is designed to be highly cost-effective by leveraging existing institutional resources, open-source software, and the provided dataset. The primary expenditures are directed towards essential computational services required for research and deployment.

The detailed breakdown of the estimated costs is as follows:

- **GPU Cloud Services:** An estimated **₹12,500** is budgeted for the intensive training and comparison of the machine learning models.
- **Cloud Server Hosting:** A cost of **₹6,000** is allocated for hosting the high-accuracy online model's API during the 3-month validation and testing period.
- **Travel for Field Testing:** A nominal amount of **₹2,500** is set aside for local travel to conduct prototype validation with farmers.
- **Contingency (10%):** A contingency fund of **₹2,100** is included to cover any unforeseen computational or miscellaneous expenses.

Total Estimated Budget: ₹23,100

7 Appendix

- The project team has prior exposure to image processing, machine learning, and computer vision concepts through academic coursework and lab projects. Students have worked on tasks such as object detection, classification, and automation using Python, OpenCV, and TensorFlow, which form the foundation for this project.
- A team member was a lead developer in an AI-powered study assistant that improved study efficiency by 40%, enabling students to generate instant summaries, flashcards, and citations using Llama 3.3, DeepSeek R1, and RAG-based retrieval.