SMART INDIA HACKATHON 2025

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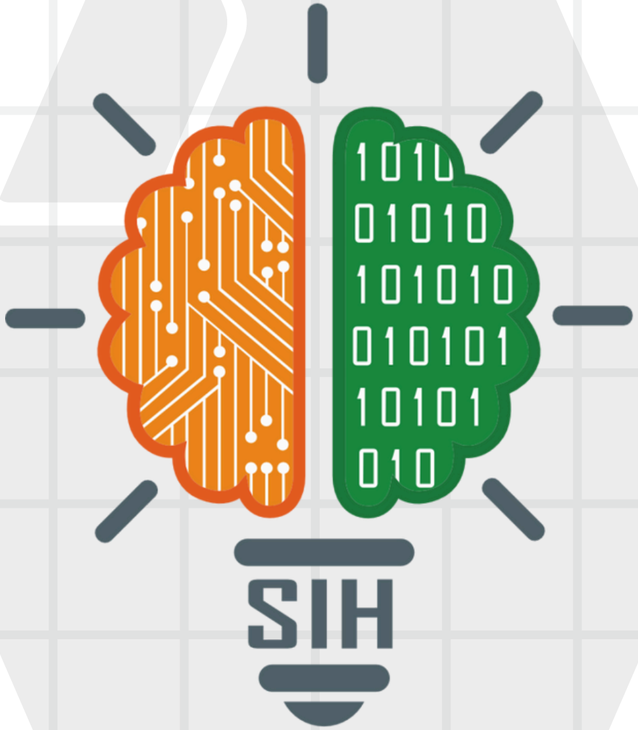
- **PROBLEM STATEMENT ID –** SIH25099
- **PROBLEM STATEMENT TITLE-** AI-powered monitoring of crop health, soil condition, and pest risks using multispectral/hyperspectral imaging and sensor data.
- **THEME-** Agriculture, FoodTech & Rural Development
- **PS CATEGORY -** Software
- **TEAM ID -**
- **TEAM NAME -** BugByte



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AI POWERED AGRICULTURE PLATFORM

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Land & Crop Assessment

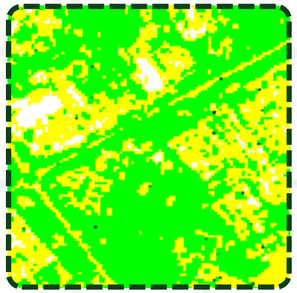
We use satellite-based hyperspectral analysis (NDVI, NDWI) to assess crop suitability. For multi-crop farms, soil data guides optimal crop placement, trained on historical datasets for better yields.

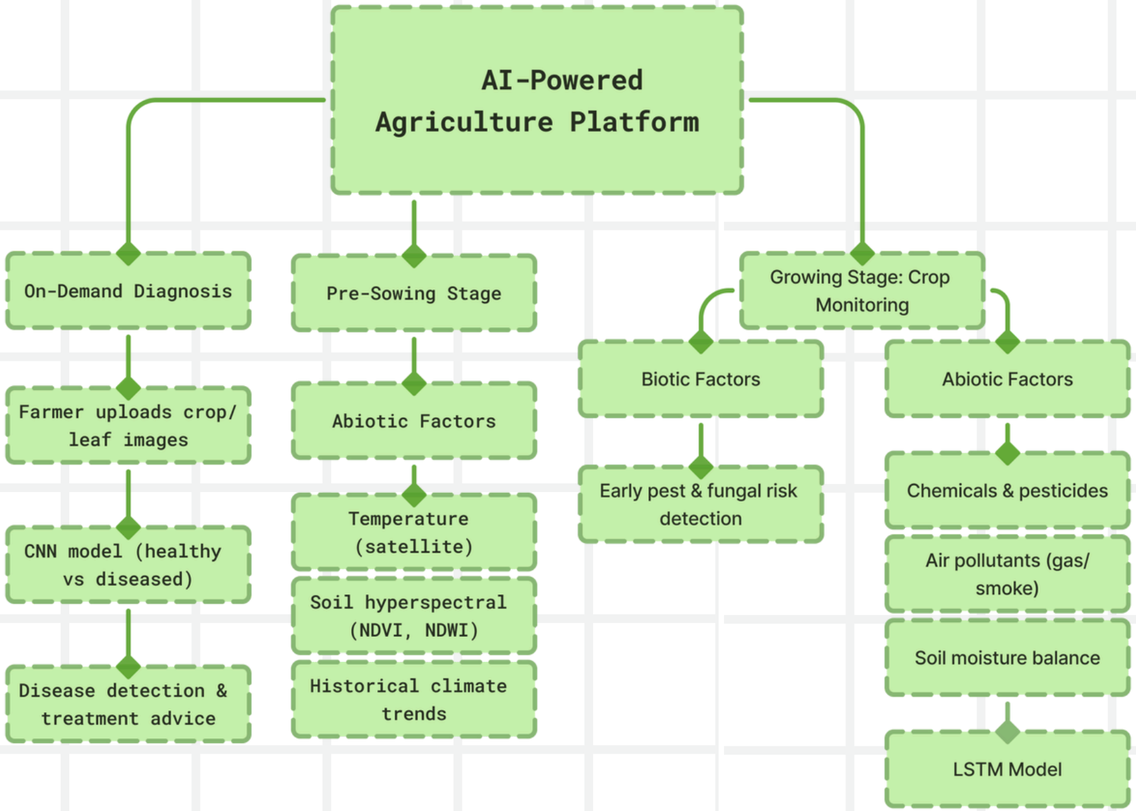
Proactive Farmer Alerts

When plant-specific thresholds are crossed, the system flags risks and instantly sends GSM alerts to farmers, enabling fast, proactive interventions.

AI-Powered Diagnosis

Farmers can upload leaf images to the app. A CNN model, trained on massive plant datasets, identifies diseases and provides immediate treatment advice.





Real-Time Field Monitoring

Field sensors track temperature, humidity, and soil moisture in real-time, offering farmers a continuous overview of crop conditions.

Environmental Analysis

Additional sensors detect nutrient imbalance, pollutants, and chemical excess, helping prevent soil degradation, pest, and fungal outbreaks.

Integrated Farming Support

By combining satellite data, sensors, and AI recognition, the platform ensures land feasibility, crop health monitoring, and instant diagnosis—supporting sustainable, high-yield farming.

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TECHNICAL APPROACH

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Collect image datasets

Process images

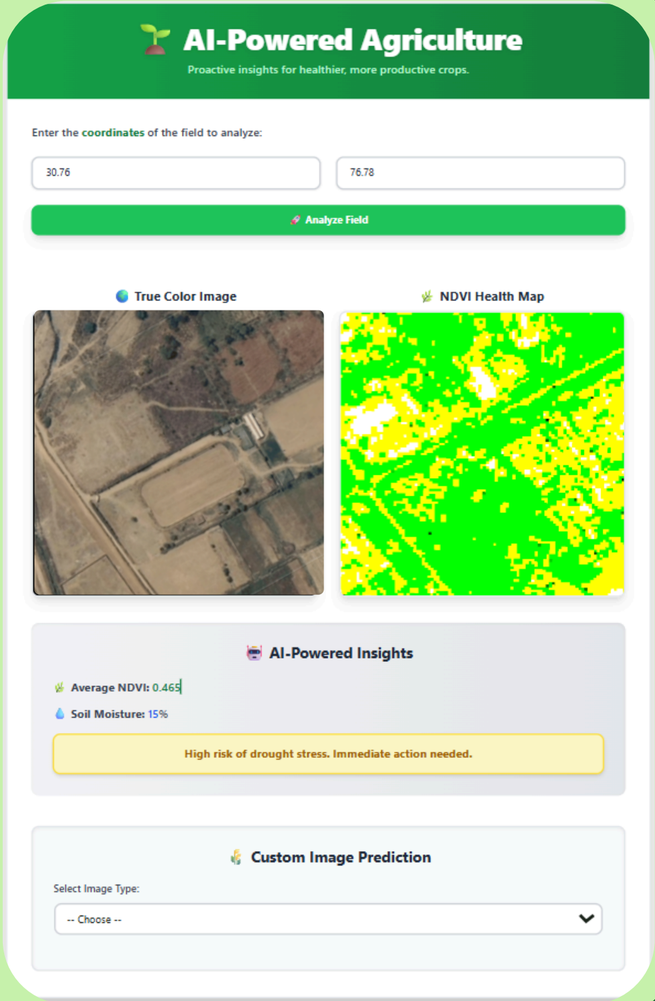
Train CNN+LSTM model

Integrate sensor data

Build user interface

Deployment

Working prototype:



Tech Stack

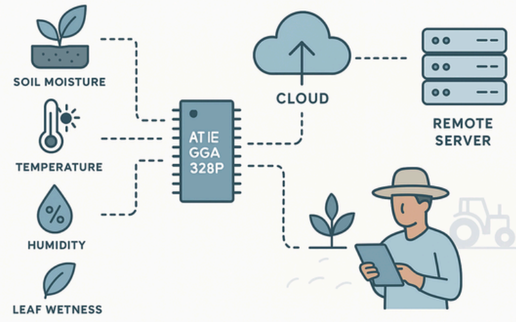
MATLAB

Main environment for image processing, data fusion, and AI modeling.

Toolboxes/Libraries

- **Hyperspectral Imaging Library**
- **Deep Learning Toolbox**
- **Image Processing Toolbox**

Frontend	Backend
React	node.js + Express
Vite	spawn



Atmega 328P IoT system links crop sensors with cloud and satellite data for smarter farming.

CNN Model

In this platform, a Convolutional Neural Network (CNN) processes multispectral and hyperspectral images to learn patterns that reveal crop health, soil conditions, and early signs of stress or disease.

Hyperspectral Analysis

Feature Extraction

- Spectral Indices (like NDVI, PRI, MCARI, etc.) tailored to vegetation.
- Red-edge analysis – sensitive to chlorophyll content.
- Water absorption bands – estimate leaf water content.

Dimensionality Reduction

- PCA (Principal Component Analysis) – compress data, preserve variance.
- Band selection algorithms – pick most informative wavelengths.

GSM Module
Send SMS or alerts without Wi-Fi. Done by connecting IoT systems to SIM cards.

Datasets

- **RGB Plant Diseases (Kaggle PlantVillage)**
- **Hyperspectral(USDA Proximal crops/weeds)**

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FEASIBILTY & VIABILITY

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Market

Moderate

- **Growing precision agriculture market** driven by climate pressures and sustainability needs.
- Need to **focus on specialty crops,** research plus strategic partnerships to improve market penetration.

Technical

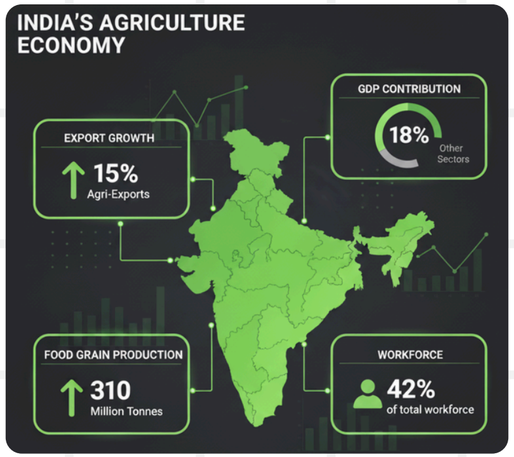
High

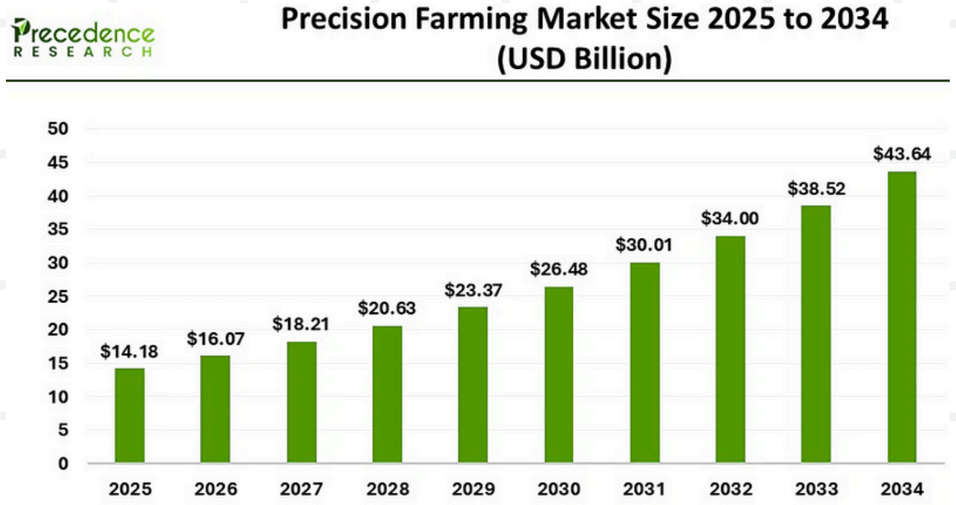
- Use of mature technologies like **hyperspectral imaging and environmental sensors.**
- But integrating multispectral imagery with real-time sensor data, **requiring sophisticated data fusion algorithms.**

Operational

Moderate

- Hurdles include **high equipment costs, farmer training needs, rural connectivity requirements.**
- May be limited to research institutions and large farms, requiring significant subsidies and infrastructure support.





Critical Risks/Challenges	Mitigation strategy
High equipment costs deterring adoption	Leasing/subscription models, government subsidies, cooperative purchasing programs
Farmer resistance to AI recommendations over traditional methods	Peer demonstration programs, transparent AI explanations, manual override options
AI model accuracy degradation and equipment failures	Continuous model retraining, redundant sensor networks, rapid replacement protocols
Intense competition from established players	Focus on niche markets, unique value propositions, strategic partnerships

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IMPACT & BENEFITS

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IMPACT

Optimized Harvest Outcomes

Our solution ensures peak crop and soil vitality from seed to harvest, resulting in more abundant yields and superior produce quality.

Proactive Crop Management

Shift from reactive problem-fixing to proactive threat prevention. Our AI model predicts stress, disease, and pest outbreaks ,safeguarding yields.

Accelerated Innovation

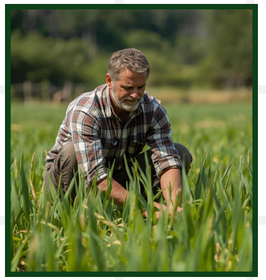
Researchers can leverage the integrated spectral and sensor data for faster validation of crop varieties, soil treatments, and new farming techniques, speeding up the innovation cycle.

Enhanced Decision-Making

A comprehensive visual dashboard with spectral health maps and trend plots. This allows farmers to understand the what and where of a problem, not just the what.

Economic Benefits

- **Increased Profitability:** Boosts farmer income by increasing yields.
- **Reduced Crop Loss:** Minimizes losses from pests and diseases through early detection and targeted intervention.
- **Market Advantage:** Produces higher-quality crops that can fetch affordable prices in the market.



Environmental Benefits

- **Sustainable Agriculture:** Promotes eco-friendly farming by minimizing chemical runoff into soil and water sources.
- **Water Conservation:** Reduces agricultural water consumption through precision irrigation.
- **Improved Soil Health:** Helps prevent soil degradation by providing insights for balanced nutrient management.

Social Benefits

- **Improved Occupational Well-being:** Enhances farmer safety and efficiency by reducing the need for strenuous manual labor.
- **Informing Public Policy:** Researchers get access to large-scale data for robust climate and agricultural modeling.
- **Bridging Research and Practice:**Uses real-world data to quickly validate new farming techniques, accelerating the adoption of innovations.

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RESEARCH AND REFERENCES

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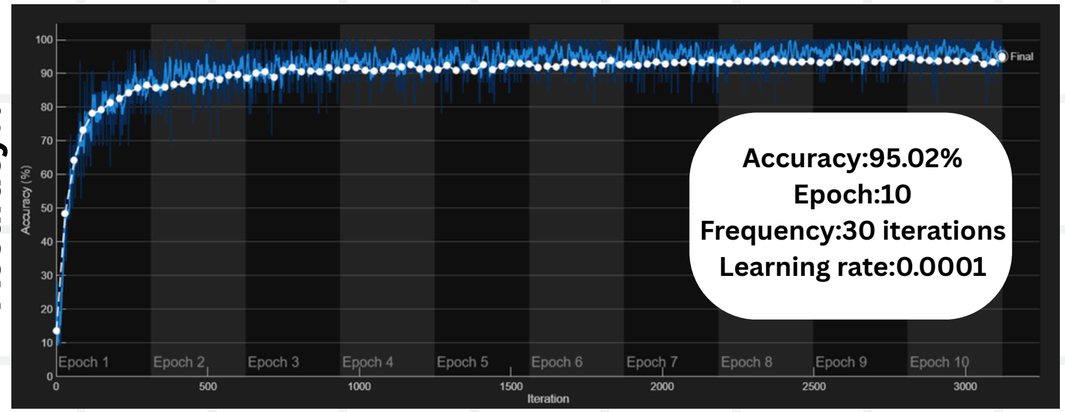
Model comparison

Model	Depth	Accuracy (Typical
AlexNet	8	82–85%
VGG-16	16	86–88%
InceptionV3	48	89–91%
ResNet-50	50	**94–96%**

Pre-processing

- **Radiometric correction** – converts raw DN (digital numbers) to reflectance.
- **Geometric correction** – align pixels spatially (important for drone/multi-scan data).
- **Noise removal** – use PCA, Savitzky-Golay filtering, or band selection to remove noisy bands.
- **Atmospheric correction** (if outdoor imaging)

Our model performance



Iterations

Utilization of LSTM model

- IoT sensors (soil moisture, temperature, humidity, pH, leaf wetness) produce continuous temporal data.

LSTM can predict:

- Crop water needs (irrigation scheduling).
- Pest/disease outbreak risks (when combined with weather sequences).
- Yield trends over the season.

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