BhuYantra

"Satellite-powered crop health insights for every farmer"

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BhuYantra is a smart earth-monitoring system that leverages satellite imagery, AI, and weather data to provide actionable crop health insights for small and marginal farmers.

Problem Statement

Background of the Problem:

Agriculture in India is highly dependent on rainfall, temperature, and soil moisture. Even small environmental changes can cause significant crop failures.

While agencies like ISRO and IMD provide satellite and weather data, most of this information is:

- Too technical for farmers to interpret

- Delivered late, after damage has already occurred

- Not accessible in regional languages or simple formats

Who is Affected?

- Small and marginal farmers (85% of India's farmers) who lack access to agronomists or timely advisories

- Agricultural field officers responsible for monitoring large rural areas

- Government/NGOs working to improve agricultural outcomes

Limitations of Current Solutions:

- Complexity: Platforms like ISRO Bhuvan and Copernicus are too technical

- Delayed advisories: Information often comes after crop loss has begun

- Low digital literacy: Many farmers struggle with non-local apps

- No early alerts: Farmers do not get proactive warnings of crop stress, irrigation needs, or encroachment

Consequences if Problem Remains Unsolved:

- Farmers continue making reactive, uninformed decisions

- Increased crop losses due to late detection

- Wastage of water, fertilizers, and resources

- Unnoticed land disputes and encroachment

- Space and AI technologies remain inaccessible to grassroots farmers

Why This Problem Must Be Solved

In an age where satellites can detect crop health from space, it is unacceptable that farmers on the ground are still guessing about irrigation, pests, or harvest timing.

👉 **BhuYantra bridges this gap by converting complex geospatial data into farmer-friendly, actionable insights.**

Our Solution – BhuYantra

What is BhuYantra?

- BhuYantra is a farmer-centric digital platform that translates satellite imagery, AI models, and weather data into simple, real-time crop health insights.
- It is specifically designed for small and marginal farmers in India, ensuring accessibility through regional languages and voice-based support.

Key Capabilities

- Monitor farm health remotely using satellite imagery

- Detect problems early such as drought stress, pest damage, or land encroachment

- Receive personalized alerts via app, SMS, or voice in local languages

- Ask questions through a chatbot (voice/text) for instant guidance

- Access weather overlays & historical data for smarter decision-making

Technologies Used

Layer	Technology
Frontend (UI)	React.js (Web), Flutter (Mobile)
Backend	Django / Node.js (REST APIs)
AI/ML	Python, OpenCV, scikit-learn
Geospatial Data	ISRO Bhuvan, Sentinel-2
Weather Data	OpenWeatherMap, IMD APIs
Notifications	Firebase, Twilio/Exotel
Voice & Language	Google TTS/STT, Hindi/Telugu/Tamil support

Unique Selling Points (USP):

- Built for small farmers → Low literacy, rural-first design

- Satellite + AI hybrid → NDVI/NDWI + ML-based insights

- Multilingual chatbot → Farmers interact in their own language

- Proactive alerts → Not just data, but actionable early warnings

- Modular design → Extendable for more crops, regions, or government use cases

One-Line Summary

👉 *"BhuYantra uses AI and satellite data to detect crop stress and alert farmers via a multilingual mobile app and chatbot."*

System Architecture

Overview:

BhuYantra follows a modular, scalable architecture that integrates satellite data, AI-powered analysis, and multi-channel delivery. The design ensures that complex geospatial data is transformed into farmer-friendly, actionable insights.

Key Components:

1 Frontend (User Interface Layer)

- Platforms: React.js (Web), Flutter (Mobile)

- Features: AOI selection, map visualization, chatbot, timeline view

- Multilingual design with icons and voice support for low-literacy farmers

2 Backend Server (Logic & API Layer)

- Technologies: Django / Node.js

- Responsibilities:

  - User authentication & AOI storage

  - Orchestrating image retrieval & preprocessing

  - Interfacing with ML engine

  - Storing results & generating alerts

3 Machine Learning Engine (Analysis Layer)

- Technologies: Python, scikit-learn, OpenCV

- Functions:

  - Perform NDVI/NDWI computations

  - Classify land condition as Healthy / Degraded / Unusual

  - Detect crop stress, flooding, or encroachment
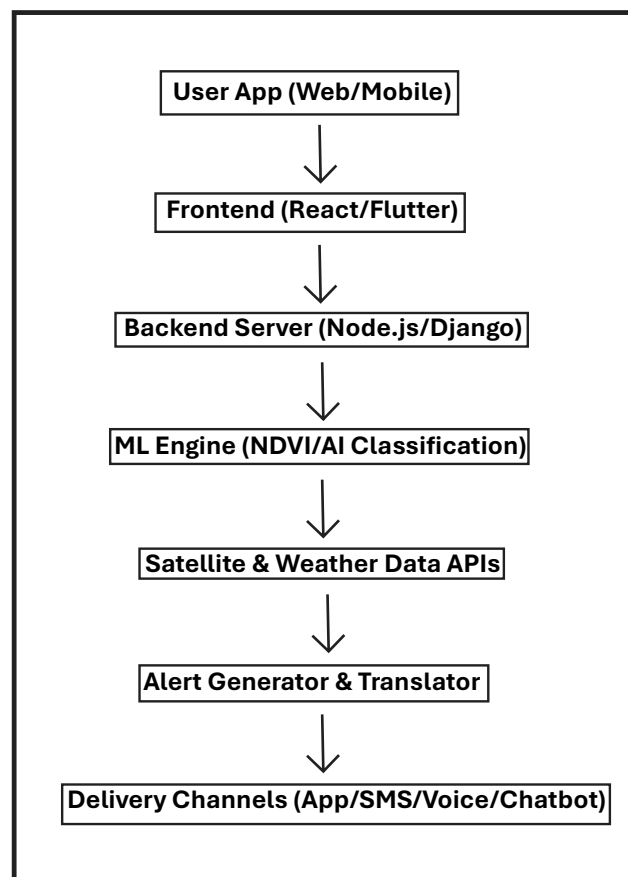
  - Generate visual heatmaps

4 Data Sources Layer (Satellite + Weather)

- Satellite Imagery: ISRO Bhuvan (LISS-4), Sentinel-2

- Weather Data: OpenWeatherMap API, IMD APIs

- Provides vegetation health, rainfall, temperature, and humidity insights

5 **Notification & Delivery Layer**

- Tools: Firebase, Twilio/Exotel

- Delivers alerts through:

    - Push notifications (app)

    - SMS / Voice (for low-internet areas)

    - Chatbot & voice assistant (local languages)

Information Flow

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│                                             │
│          User App (Web/Mobile)              │
│                   ↓                         │
│          Frontend (React/Flutter)           │
│                   ↓                         │
│       Backend Server (Node.js/Django)       │
│                   ↓                         │
│     ML Engine (NDVI/AI Classification)      │
│                   ↓                         │
│       Satellite & Weather Data APIs         │
│                   ↓                         │
│        Alert Generator & Translator         │
│                   ↓                         │
│  Delivery Channels (App/SMS/Voice/Chatbot)  │
│                                             │
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Key Features & Benefits

Key Features

1. **AOI Farm Selection & Management**

   o Farmers draw or upload farm boundaries on the map.

   o Multiple fields can be saved under one profile.

   o Continuous monitoring ensures regular updates on each farm.

2. **Satellite-Based Crop Monitoring**

   o Uses Sentinel-2 and ISRO Bhuvan (LISS-4) imagery.

   o Multi-temporal NDVI/NDWI analysis detects vegetation health and water stress.

   o Identifies deforestation, encroachment, and flooding.

3. **AI-Powered Crop Health Classifications**

   o Machine learning models classify farms into Healthy, Degraded, or Unusual.

   o Generates color-coded maps, heatmaps, and visual overlays for clarity.

   o ML adapts over time with regional crop data (continuous improvement).

4. **Smart Real-Time Alerts & Notifications**

   o Sends early warnings via app, SMS, or voice call.

   o Alerts include: *"50% NDVI drop in north section of farm → possible drought stress."*

   o Farmers can receive alerts even in low-internet regions.

5. **Multilingual & Voice-Enabled Chatbot**

   o Farmers interact using local languages (Hindi, Telugu, Tamil, etc.).

   o Voice-based interface for low-literate farmers.

   o Q&A system: Farmers can ask questions like *"Kal ki barish ka kya asar hai?"* and get instant answers.

6. **Integrated Weather Overlay**

   o Real-time rainfall and temperature data from IMD & OpenWeatherMap.

   o Farmers can see weather-crop health correlation.

   o Predictive insights: *"Rainfall deficit may cause crop stress in 3 days."*

7. **Historical Timeline & Comparison View**

   o NDVI/NDWI trend analysis over 30, 60, 90+ days.

   o Side-by-side comparison of crop condition at different times.

   o Visual storytelling of farm health → helps in planning irrigation, fertilizers, and harvests.

8. **Multi-Channel Delivery System**

   o App push notifications, SMS alerts, WhatsApp integration, and voice calls.

   o Farmers never miss critical updates.

   o Alerts designed in simple icons + images for clarity.

9. **Community & Officer Dashboard (Future Scope)**

   o Village-level / FPO-level dashboards for monitoring clusters of farms.

   o Helps NGOs, Panchayats, and Govt. officers track multiple AOIs at once.

Benefits

✓ **For Farmers**

   o Early detection of stress prevents loss of income.

   o Saves on unnecessary water, fertilizer, and pesticide use.

   o Accessible through regional languages and voice assistance.

   o Improves confidence in decision-making for irrigation & harvesting.

✓ **For Agricultural Officers & NGOs**

   o Easy monitoring of large regions at once.

   o Provides cluster-level insights for better resource allocation.

   o Strengthens the impact of government schemes.

✓ **For Policymakers**

   o Enables data-driven planning at block/district level.

   o Assists in crop insurance validation (PMFBY).

   o Useful for monitoring MNREGA or afforestation projects.

✓ **Economic & Environmental Impact**

   o Reduces wastage of water and fertilizers.

   o Prevents avoidable crop losses, improving farmer income.

   o Promotes sustainable agriculture practices.

✓ **Scalability & Accessibility**

   o Works across regions → supports multiple crops & states.

   o Designed as a low-cost MVP (₹5,500–₹12,000/month).

   o Can scale to national deployment using cloud infra.

Cost & Scalability

Estimated Cost for MVP (Minimum Viable Product):

The initial deployment of BhuYantra as a small-scale MVP (for ~100 farmers) is designed to be **low-cost and sustainable**.

Category	Estimated Monthly Cost	Details
Satellite Data	₹0	Free access from ISRO Bhuvan, Sentinel-2, Google Earth Engine
Weather & Map APIs	₹2,000 – ₹4,000	OpenWeatherMap (Pro plan), optional map hosting
SMS / Voice Alerts	₹1,500 – ₹3,000	Twilio/Exotel services for ~500 notifications/month
Cloud Hosting	₹1,000 – ₹3,000	AWS EC2 / Vercel / Heroku for backend + database hosting
AI Model Training	₹0 – ₹1,000 (one-time)	Training ML models locally (GPU not needed initially)
Voice & Language APIs	₹1,000 – ₹2,000	Google Cloud TTS/STT for chatbot support
Dev & Testing Tools	₹0 – ₹500	Free open-source tools (VS Code, Postman, GitHub)

Total Estimated Monthly Cost:
➡️ **₹5,500 – ₹12,000** (depending on features enabled)

Cost Reduction Strategies

- Use free-tier APIs (Firebase, limited SMS credits, free cloud credits from AWS/GCP).

- Begin with push notifications & WhatsApp before scaling to SMS/voice.

- Host backend locally during prototype stage.

- Apply for student/startup cloud credits (AWS Activate, GitHub Student Pack).

Scalability Roadmap

- ➤ **Phase 1 – Pilot (100–500 farmers)**

  - Local MVP with app + SMS alerts.

  - Validates usability & farmer adoption.

- ➤ **Phase 2 – Regional Expansion (500–5,000 farmers)**

  - Add multilingual chatbot.

  - Partner with NGOs & KVKs (Krishi Vigyan Kendras).

  - Expand infrastructure using **cloud hosting**.

- ➤ **Phase 3 – Statewide Deployment (5,000+ farmers)**

  - Introduce **cluster dashboards** for FPOs & officers.

  - Integrate with **crop insurance schemes (PMFBY)**.

  - Optimize AI with region-specific datasets.

- ➤ **Phase 4 – Nationwide Scale (1M+ farmers)**

  - Incorporate **IoT soil & weather sensors**.

  - Add **drone integration** for high-resolution mapping.

  - Government collaboration for **agri-policy monitoring**.

Why BhuYantra is Scalable

- **Free & reliable data sources** (satellites, weather APIs).

- **Modular architecture** (can plug in new crops, languages, devices).

- **Cloud-native backend** for elastic scaling.

- **Farmer-first design** → multilingual, voice-based, offline support.

- **Policy-ready** → easily integrates with government programs.

👉 *BhuYantra is not just a project — it is a cost-effective, scalable, and future-ready solution capable of serving farmers across India, from small villages to national-scale deployments.*

Conclusion & Vision

Purpose Beyond Technology:

BhuYantra is more than just an application. It is a **mission to democratize access to space and AI technologies** for India's small and marginal farmers, who form the backbone of the nation's agriculture.

Despite living in an age of **satellites, AI, and real-time data**, many farmers still depend on guesswork, tradition, or delayed advisories for decisions about irrigation, pest control, and harvesting.

👉 BhuYantra changes this by delivering **timely, farmer-friendly, and actionable insights** directly into their hands.

Our Vision:

- Bring the power of satellites and AI to every farmer.

- Deliver insights in regional languages & simple formats.

- Bridge the gap between complex space data and grassroots usability.

- Empower farming communities with knowledge, not just raw data.

Why It Matters:

- **Food security begins at the farm** – early detection prevents crop failures.

- **Satellite data is abundant but underutilized** – BhuYantra makes it actionable.

- **AI is powerful only when it serves the grassroots** – our focus is inclusivity.

- **Sustainable farming** – reduces waste of water, fertilizers, and resources.

Future Path:

- Drone integration for ultra-high-resolution farm mapping.

- IoT sensors to complement satellite data with hyper-local measurements.

- Smarter AI models trained with ground-truth data from farmers.

- Collaboration with government schemes like **PMFBY & KVKs**.

- Expansion to multi-crop, multi-state deployment for nationwide adoption.

"We don't just want to build an app. We want to build trust in technology — for the farmer, by the farmer, and from the skies."

References & Acknowledgments

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Thank You