

Krushisetu — An AI-Powered Agricultural Decision Support Platform with Conversational AI, Weather-Based Disease Risk Forecasting, and Real-Time Market Intelligence

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Abstract - While AI-powered plant disease identification has advanced rapidly, existing systems typically stop at diagnosis—leaving farmers without actionable guidance, weather-aware planning, market pricing intelligence, or the ability to ask follow-up questions. This paper presents KrushiSetu, a comprehensive Agricultural Decision Support Platform that extends beyond disease classification to provide an integrated ecosystem of farmer-centric services on a single mobile application. The platform integrates five key capabilities: (1) a context-aware Conversational AI Advisor with persistent chat memory, enabling farmers to ask follow-up questions about diagnosed diseases across sessions; (2) a Weather-Based Disease Risk Forecasting engine that correlates 5-day weather data from the OpenWeatherMap API with phytopathological risk models to predict fungal disease risk levels (Low/Medium/High); (3) Real-Time Mandi (Agricultural Market) Price Integration using India's national data.gov.in API, with AI-powered multilingual search translation enabling vernacular queries; (4) a Persistent Scan History System that stores diagnosis results, leaf images, and conversation logs locally for longitudinal crop health tracking; and (5) a fully Trilingual User Interface (English, Hindi, Marathi) built with Jetpack Compose and Material Design 3, featuring animated onboarding, dark/light theme support, and voice input for field use. The platform is implemented as a native Android application using the MVVM architecture pattern with Kotlin Coroutines, DataStore Preferences, and Ktor HTTP networking. By unifying disease diagnosis with weather intelligence, market data, and conversational AI into a single accessible interface, KrushiSetu transforms the farmer's smartphone into a holistic agricultural companion that supports the

complete crop management lifecycle.

Keywords: Agricultural Decision Support, Conversational AI, Weather Forecasting, Disease Risk Prediction, Mandi Prices, Multilingual Interface, Jetpack Compose, Material Design 3, Persistent Chat Memory, Precision Agriculture.

1. INTRODUCTION

1.1 Beyond Diagnosis: The Need for Integrated Decision Support

The agricultural sector has seen significant advances in AI-powered disease identification, with deep learning systems achieving laboratory accuracies exceeding 95%. However, disease identification alone is insufficient for effective crop management. A farmer who receives a diagnosis of "Tomato Late Blight" still faces critical unanswered questions:

What treatment should I apply? What chemical, at what dosage, and how frequently?

Should I spray today? Will rain wash off the chemical? Is the humidity conducive to disease spread?

What is the market price of my crop? Should I harvest now or wait for better prices?

Can I ask more questions? What if I need clarification about dosage or organic alternatives?

Currently, farmers must consult multiple disconnected sources—disease identification apps, weather apps, Mandi price websites, and phone calls to agricultural extension officers—to make a single crop management decision. This fragmentation is particularly burdensome for smallholder farmers with limited digital literacy.

1.2 Language Accessibility Crisis

Agricultural technology in India faces a critical language barrier. While 65% of India's farming population speaks Hindi and regional languages as their primary tongue, the vast majority of agricultural apps and advisory services operate exclusively in English. In Maharashtra—India's second-largest agricultural economy—Marathi is the primary language of communication for over 83 million speakers. Any practical agricultural platform must deliver information in the farmer's native language to be truly effective.

1.3 The KrushiSetu Platform Approach

KrushiSetu addresses these challenges through a unified Agricultural Decision Support Platform that integrates five interconnected modules into a single native Android application:

Conversational AI Advisor: A persistent, context-aware chatbot that remembers previous conversations and responds in the farmer's language.

Weather-Based Disease Risk Forecasting: Automated correlation of weather data with disease risk models.

Mandi Price Intelligence: Real-time government commodity pricing with AI-powered multilingual search.

Persistent Scan History: Longitudinal crop health tracking with image and conversation archival.

Trilingual UI/UX: Complete interface localization in English, Hindi, and Marathi with voice input support.

(LMS), SmartEduHub focuses on simplicity, security, and intelligence. It introduces features like real-time analytics, automated notifications, and personalized dashboards. The system ensures that each user—student, teacher, or administrator—has controlled access based on predefined roles, improving both usability and security.

2. LITERATURE SURVEY

2.1 Conversational AI in Agriculture

Recent advances in Large Language Models (LLMs) such as GPT-4, Google Gemini, and Meta Llama have enabled natural language interfaces for agricultural advisory. However, most implementations are stateless—each query is treated independently without memory of previous interactions, severely limiting the conversational depth.

2.2 Weather and Disease Correlation

Phytopathological research has established strong correlations between weather conditions and plant disease outbreaks. Magarey et al. (2005) demonstrated that temperature ranges of 20–30°C combined with relative humidity above 75% create optimal conditions for fungal pathogens including *Phytophthora*, *Alternaria*, and *Cercospora* species. Integration of weather APIs with disease risk models remains underexplored in mobile agricultural platforms.

2.3 Market Intelligence for Farmers

The Government of India's Open Government Data (OGD) Platform provides real-time agricultural commodity pricing through RESTful APIs. However, direct API access requires English-language queries using standardized commodity names—a barrier for farmers who search in Hindi or Marathi using colloquial or abbreviated terms.

2.4 Mobile UI/UX for Rural Users

Studies on agricultural app adoption in India (Trendov et al., 2019) highlight that simplicity, vernacular support, and minimal text input are critical design factors. Material Design 3's adaptive theming and Jetpack Compose's declarative UI paradigm provide modern tools for building accessible interfaces.

2.5 Research Gap

No existing single-platform solution integrates AI-diagnosed disease results with weather-aware risk forecasting, real-time market pricing, persistent conversational follow-up, and complete trilingual support. KrushiSetu fills this gap.

3. METHODOLOGY

3.1 System Architecture

KrushiSetu is built using the MVVM (Model-View-ViewModel) architecture pattern with the following technology stack:

Component	Technology
Language	Kotlin
UI Framework	Jetpack Compose + Material Design 3
Camera	CameraX (camera-core, camera2, lifecycle, view)
Networking	Ktor HTTP Client (OkHttp engine)
Serialization	kotlinx.serialization (JSON)
Storage	Android Internal Storage + DataStore Preferences
Image Loading	Coil Compose
Animations	Lottie Compose
Location	Google Play Services Location
AI Providers	Google Gemini API, Groq API

3.2 Conversational AI with Persistent Memory

Architecture:

The conversational AI module is implemented as a context-aware chat system with full session persistence:

- **Context Injection:** Each AI query includes the disease name from the active scan as context, ensuring all responses are relevant to the diagnosed condition.
- **Conversation History:** Previous user-AI message pairs are serialized and included in the API request,

enabling the AI to reference earlier exchanges (e.g., "What about the dosage you mentioned earlier?").

- **Dual-Provider Text AI:** Text queries use Gemini `gemini-2.0-flash-lite` as primary and Groq `llama-3.3-70b-versatile` as fallback.

- **Personality Design:** The AI is prompted as "a friendly and knowledgeable agriculture assistant named KrushiSetu AI" that responds naturally and conversationally while providing practical farming advice.

- **Language-Aware Responses:** The system prompt specifies the target language (English/Hindi/Marathi), and the AI generates responses natively in that language.

Persistence Implementation:

- Chat messages are stored as JSON files in Android's internal storage (`chats/chat_{scanId}.json`).
- Each message entity contains: text content, sender flag (user/AI), and Unix timestamp.
- When a farmer revisits a historical scan, the complete chat history is restored, enabling seamless continuation of previous conversations.
- Chat history is maintained independently per scan record, supporting multiple concurrent disease conversations.

Voice Input:

- Android's `RecognizerIntent` provides speech-to-text input, enabling hands-free operation while the farmer is in the field.
- The recognized text is automatically submitted as a chat query.

3.3 Weather-Based Disease Risk Forecasting

Data Source: OpenWeatherMap 5-day/3-hour forecast API using the farmer's GPS coordinates (obtained via Google Play Services FusedLocationProviderClient).

Processing Pipeline:

- **Location Acquisition:** GPS coordinates are fetched using the device's last known location.
- **API Request:** The forecast is fetched with metric units (°C, m/s).
- **Daily Aggregation:** 3-hourly entries are grouped by date, computing:

- Minimum and maximum temperature - Average humidity - Average wind speed - Dominant weather condition (from the latest entry of the day) - Weather icon code for visual display

- **Disease Risk Algorithm:** Each day is assigned a risk level based on phytopathological correlations:

Conditions	Risk Level	Advisory Message
Warm (20–30°C) + Rain + Humid (>75%)	High	High fungal disease risk. Inspect crops and spray preventively.
Humid (>75%) + Warm (20–30°C)	Medium	Monitor for early signs of blight or mildew.
Rain expected	Medium	Avoid spraying today—chemicals will wash off.

- **Display:** A 5-day forecast strip is shown within the scan results, with each day showing temperature range, humidity, weather icon, wind speed, risk badge, and actionable advisory text.

3.4 Real-Time Mandi Price Integration

Data Source: Government of India's Open Government Data (OGD) Platform API (api.data.gov.in/resource/9ef84268-d588-465a-a308-a864a43d0070). **Features:**

- **Multi-Parameter Filtering:** Commodity name, state (default: Maharashtra), district (34 Maharashtra districts), market name, variety (Local, Hybrid, Desi, etc.), and grade (FAQ, Large, Medium, etc.).
- **AI-Powered Multilingual Search:** When a farmer types a commodity name in Hindi or Marathi (e.g., "कांदा" or "pota"), the AI translation module:

1. Detects non-ASCII characters indicating vernacular input.
2. Sends the query to the AI with the prompt: "Translate and CORRECT the following crop or market name to its full standard version in English."
3. Returns

the corrected English commodity name (e.g., "Onion", "Potato") for the API query.

- **Data Fields Displayed:** State, district, market name, commodity, variety, grade, arrival date, minimum price (₹/quintal), maximum price, and modal price.
- **Pagination:** Results are limited to 30 records per query for performance.

3.5 Persistent Scan History System

Implementation:

The history system uses a file-based persistence approach:

- **Image Storage:** Each scan's leaf photo is saved as a JPEG file (`img_{timestamp}.jpg`) in the app's internal storage (`history/` directory).
- **Metadata Storage:** Scan metadata (disease name, confidence, advice, forecast, location, stage, error message, leaf validation flag, source label) is serialized as a JSON array in `history_meta.json`.
- **History Limit:** The last 50 scans are retained to manage storage usage.
- **History Browsing:** The History tab displays scan cards with thumbnail images, disease names, dates, and AI verification badges.
- **Scan Restoration:** Tapping a historical scan restores the complete results screen including diagnosis, treatment advice, weather data, and chat history.

3.6 Trilingual User Interface

Localization System:

A custom `Loc` (Localization) object provides runtime string translation across 50+ UI keys in three languages:

- **English (en):** Default language with full technical terminology.
- **Hindi (hi):** Complete localization including agricultural terms (e.g., "बीमारी" for Disease, "उपचार" for Treatment, "मंडी भाव" for Mandi Prices).
- **Marathi (mr):** Complete localization with Maharashtra-specific agricultural vocabulary (e.g., "रोग" for Disease, "बाजार भाव" for Market Prices, "हवामान अंदाज" for Weather Forecast).

UI Screens:

- **Splash Screen:** Animated brand presentation with scale and fade transitions.
- **Onboarding (3 pages):** HorizontalPager-based carousel with custom illustrations, dot indicators, and localized text. Shown only on first launch (persisted via DataStore).

- **Home Screen:** Live CameraX preview with one-tap capture, gallery upload (PickVisualMedia), processing status indicators ("ML"/"AI"), and instruction guide.
- **Results Screen:** Sticky tab navigation (Disease/Treatment/Solution/Forecast) with scroll-synced tab highlighting, AI Verified badges, urgency bands, and floating "Ask AI" button.
- **History Screen:** Scrollable list of past scans with thumbnails, disease names, and tap-to-restore functionality.
- **Mandi Screen:** Search bar, district/variety/grade dropdown filters, and commodity price cards.
- **Settings Screen:** Theme selector (Light/Dark/System), language picker, and app information.

Bottom Navigation: Four-tab NavigationBar (Home, History, Mandi, Settings) with Material3 styling and LeafGreen accent color. **Theming:**

- Light and Dark theme support using Material3 dynamic color system.
- Custom color tokens: LeafGreen (#2E7D32), BarkBlack for branded elements.

4. RESULTS AND DISCUSSION

4.1 Platform Performance

Feature	Performance
Chat Response Time	1–3 seconds
Weather Forecast Load	<2 seconds
Mandi Price Query	<3 seconds
AI Search Translation	<1 second
APK Size	~25 MB
App Cold Start	~2.5 seconds

4.2 Conversational AI Effectiveness

The persistent chat memory significantly enhances the farmer's experience compared to stateless advisory systems:

- **Contextual Follow-ups:** Farmers can ask "What about organic alternatives?" after receiving chemical advice, and the AI references the previously discussed disease and chemicals.
- **Dosage Clarification:** Questions like "How often should I spray?" receive contextually accurate responses based on the specific disease and treatment discussed earlier.
- **Cross-Session Memory:** Revisiting a 3-day-old scan restores the complete conversation, allowing the farmer to continue from where they left off.

4.3 Weather-Disease Risk Correlation

The disease risk algorithm provides practical, actionable guidance:

- **Spray Timing:** "Avoid spraying today—chemicals will wash off" prevents wasted expenditure on rainy days.
- **Proactive Monitoring:** "High fungal disease risk" alerts prompt farmers to inspect crops before symptoms appear.
- **Planning:** 5-day outlook enables farmers to plan spray schedules around weather windows.

4.4 Mandi Price Utility

The AI-powered multilingual search removes a critical friction point:

- **Vernacular Input:** Farmers searching "टमाटर" (Marathi for Tomato) or "प्याज" (Hindi for Onion) receive correct English API results.
- **Fuzzy Correction:** Partial inputs like "pota" are auto-corrected to "Potato" by the AI translator.
- **Decision Support:** Comparing prices across markets and districts helps farmers choose optimal selling locations.

4.5 Challenges and Limitations

- **Weather API Dependency:** The OpenWeatherMap free tier allows 60 calls/minute, sufficient for individual use but potentially limiting for scaled deployment.
- **Mandi Data Freshness:** Government API data may be delayed by 1–2 days from actual market arrivals.
- **Vernacular AI Quality:** Hindi and Marathi responses from English-trained LLMs occasionally

exhibit unnatural phrasing or terminology inconsistencies.

- **Offline Chat Limitation:** Conversational AI requires internet; offline mode provides only the stored historical chat, not new responses.
- **Location Accuracy:** GPS-based weather fetching depends on device location services; indoor or low-signal environments may default to approximate coordinates.

4.6 Future Enhancements

- **Community Knowledge Network:** Farmer-to-farmer knowledge sharing where successful treatment outcomes are crowdsourced and validated.
- **Predictive Disease Modeling:** ML models predicting disease outbreaks 7–14 days in advance using weather trends and historical incidence data.
- **IoT Sensor Integration:** Connectivity with soil moisture, humidity, and temperature sensors for proactive monitoring.
- **Crop Calendar Integration:** Season-specific advisory tied to crop growth stages and local planting calendars.
- **Offline Chat with On-Device LLM:** Deploying compact LLMs (Gemma 3n, Phi-3 Mini) on-device for fully offline conversational AI.
- **Regional Language Expansion:** Adding Kannada, Telugu, Tamil, and Gujarati for pan-India coverage.

5. CONCLUSION

KrushSetu demonstrates that effective agricultural technology must extend beyond disease identification to provide holistic decision support. By integrating context-aware conversational AI with persistent memory, weather-based disease risk forecasting, real-time market intelligence with AI-translated vernacular search, and a fully trilingual interface, the platform addresses the complete crop management lifecycle within a single smartphone application. The persistent chat memory enables natural, multi-turn advisory conversations across sessions. The weather-disease risk correlation provides actionable spray timing and proactive monitoring guidance. The Mandi price integration with AI-powered multilingual search removes language barriers from market intelligence access. Together, these capabilities transform a disease scanner into a comprehensive agricultural companion, empowering India's farming community with accessible, expert-grade decision support in their own language.

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