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AGENTI AI POWERED FARM ADVISOR SYSTEM

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Abstract: *Agriculture is the backbone of the Indian economy, yet a large number of farmers face difficulties in selecting suitable crops and managing farm resources effectively due to limited access to expert guidance and real-time information. Conventional agricultural advisory practices are mostly experience-driven and do not systematically consider multiple influencing factors such as soil conditions, water availability, pest issues, weather variations, seasonal patterns, and geographical location. This paper presents AGENTI, an Agentic AI Powered Farm Advisor System that employs a multi-agent architecture where five specialized AI agents independently analyse distinct agricultural parameters. A centralized Decision Fusion Agent integrates the outputs of all individual agents using a weighted scoring algorithm to generate accurate, explainable crop and mixed-cropping recommendations. The system supports trilingual interaction (English, Telugu, Hindi) with voice input/output via the Web Speech API. Experimental results demonstrate reliable performance across 12 Indian crops and 15 states, providing an accessible, data-driven agricultural advisory tool for Indian farmers.*

Keywords: *Agentic AI, Multi-Agent System, Crop Recommendation, Precision Agriculture, Decision Fusion, React TypeScript, Trilingual Interface, Voice I/O, Smart Farming*

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1. INTRODUCTION

Agriculture is the backbone of the Indian economy, with over 58% of the rural population depending on it as their primary livelihood. However, farmers often face significant challenges in making optimal crop selection decisions due to the complex interplay of various factors such as soil type, water availability, weather conditions, pest risks, and seasonal patterns. Traditional farming decisions are largely based on experience and intuition, which may not always account for the multitude of variables involved.

With the advancement of Artificial Intelligence (AI) and multi-agent systems, there is an opportunity to build intelligent decision support systems that can analyse multiple agricultural parameters simultaneously and provide data-driven crop recommendations. The Agentic AI Powered Farm Advisor System (AGENTI) addresses this need by employing a multi-agent architecture where specialized AI agents independently analyse distinct agricultural parameters and a Decision Fusion Agent aggregates their findings using a weighted scoring model.

The system provides Indian farmers with personalized crop recommendations by considering their specific soil type, water source, farm area, geographical location, current season, and real-time weather conditions. The system supports trilingual interaction (English, Telugu, Hindi) and includes voice input/output capabilities, making it accessible to farmers with varying levels of digital literacy.

2. LITERATURE SURVEY

Multi-agent systems (MAS) have been extensively explored in agricultural decision-making research. Singh et al. (2020) used Random Forest and Decision Trees for crop prediction based on soil parameters [2]. Pudumalaretal. (2017) developed a crop recommendation system using ensemble techniques; however, most existing systems use a single monolithic model rather than specialized agents [3]. Mas et al. (2014) demonstrated the effectiveness of multi-agent systems in precision agriculture for distributed decision-making [4]. O'Grady et al. (2017) explored intelligent

agent-based systems for crop management, highlighting the advantage of modular, independently operating agents [5].

Kumar et al. (2019) proposed weather-integrated crop advisory systems that incorporate real-time meteorological data; the integration of weather analysis with soil and water data has been shown to significantly improve recommendation accuracy [6]. Patel et al. (2018) highlighted the importance of voice-based interfaces for agricultural systems targeting farmers with limited digital literacy, particularly in Indian languages like Hindi and Telugu [7]. This research forms the foundation for the trilingual voice-enabled interface in AGENTI.

Existing crop recommendation systems predominantly rely on machine learning models trained on historical agricultural datasets. These systems typically operate as black-box models where the reasoning behind recommendations is not transparent to the user, are available only in English, and do not provide comprehensive advisory reports. The comparison in Table 1 summarizes the key differences between the proposed system and existing approaches.

Table 1: Comparison of AGENTI with Existing Systems

Feature	Traditional ML	Rule-Based Expert	AGENTI (Proposed)
Architecture	Monolithic model	Single expert system	Multi-agent + Fusion
Transparency	Black-box	If-then rules	Per-agent reasoning
Modularity	Low	Medium	High (5 independent agents)
Language	English only	Limited	EN, Telugu, Hindi
Voice I/O	None	None	Speech Recog. + TTS
Reports	Basic	Template-based	Professional HTML
Weather	Not integrated	Manual input	Simulated intelligence

3. PROPOSED SYSTEM

The AGENTI system addresses the limitations of existing crop recommendation systems through a modular multi-agent architecture. The system employs five specialized AI agents, each analysing a distinct agricultural parameter independently, and a sixth Decision Fusion Agent that aggregates all outputs to produce a final weighted recommendation. The architecture is designed to be modular, scalable, and fully explainable — each agent's score and reasoning text are visible to the user.

3.1 Multi-Agent Architecture

The five core agents and their respective weights in the decision fusion formula are shown in Table 2. Each agent evaluates all 12 crops in the database independently and returns a score between 0 and 100 along with an analysis text explaining its reasoning.

Table 2: Agent Weights in Decision Fusion Formula

Agent Name	Parameter Analysed	Weight
Soil Analysis Agent	Soil type compatibility	30%
Water Availability Agent	Water source adequacy	25%
Seasonal Pattern Agent	Season alignment	15%
Weather Intelligence Agent	Temperature suitability	15%
Pest Risk Agent	Pest vulnerability	15%

3.2 Decision Fusion Formula

The Decision Fusion Agent combines individual agent scores using the following weighted formula:

$$\textit{Total Score} = (\textit{Soil} \times 0.30) + (\textit{Water} \times 0.25) + (\textit{Season} \times 0.15) + (\textit{Weather} \times 0.15) + (\textit{Pest} \times 0.15)$$

Crops are ranked by total score. The highest-scoring crop becomes the primary recommendation; the next five become alternatives. Risk level is computed based on individual agent failures, and sustainability score is derived from the total score with an environmental bonus factor.

3.3 Crop Database

The system maintains a database of 12 major Indian crops: Rice, Wheat, Cotton, Sugarcane, Groundnut, Maize, Sorghum, Chickpea, Tomato, Turmeric, Chilli, and Onion. Each crop profile contains 15 attributes including trilingual names (English, Telugu, Hindi), compatible soil types, water requirement level, temperature range, growing seasons, pest risk level, nutrient needs, growth duration, estimated yield per acre, and companion crops for mixed-cropping strategies.***3.4 Transparent Reasoning***

Unlike existing black-box systems, AGENTI makes each agent's individual score and analysis text visible to the user. Farmers can understand exactly why a particular crop was recommended over alternatives. The system also provides mixed cropping strategy suggestions with companion crop pairings, risk assessment (Low/Medium/High), sustainability score, and irrigation advice — all in the selected language.

4. SYSTEM DESIGN

4.1 System Architecture

The system follows a layered client-side architecture built with React 18 and TypeScript. The architecture consists of three main layers: (i) Presentation Layer — handles user interface components including Header Bar, Hero Section, Input Panel, Weather Card, Recommendation Dashboard, Charts Section, and ReportGenerator; (ii) Business Logic Layer — contains the multi-agent AI engine (agentEngine.ts) with five specialized agent functions and the Decision Fusion Agent; and (iii) Data Layer — manages the crop database, internationalization translations, and browser local Storage for user authentication and session management.

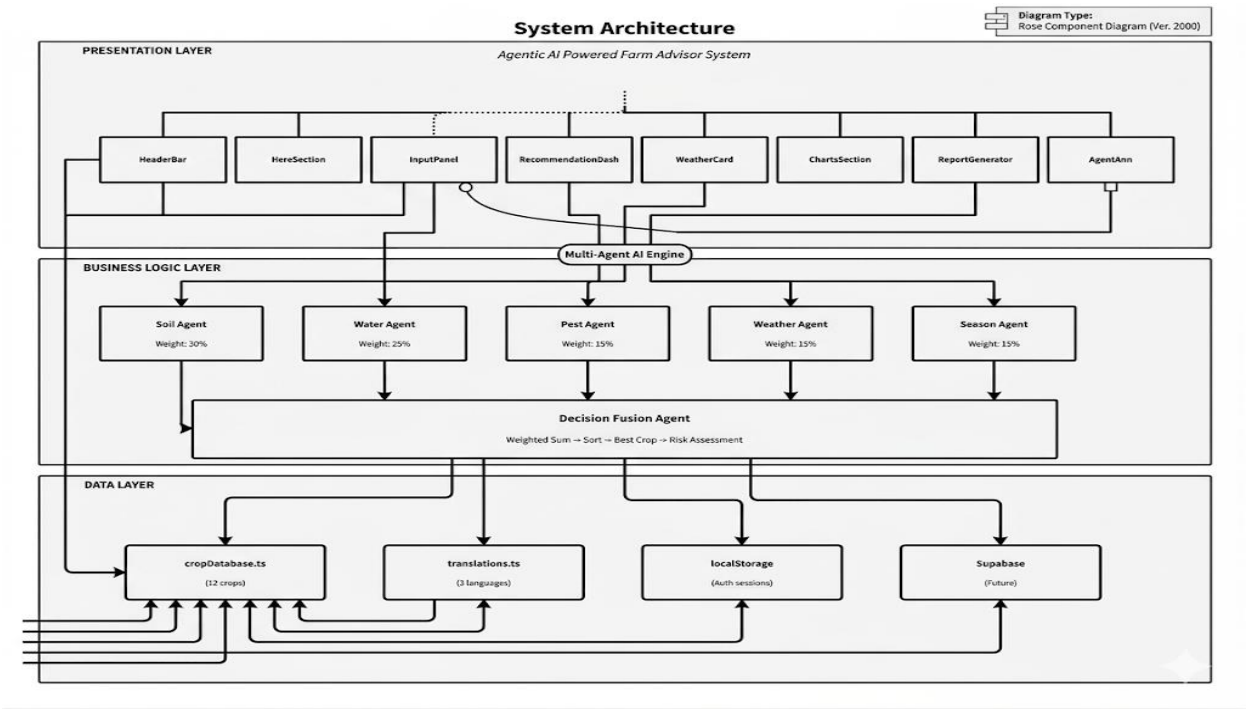

Fig. 4.1: System Architecture of AGENTI

4.2 Technology Stack

Table 3: Technology Stack and Requirements

Component	Technology / Tool
Frontend Framework	React 18 + TypeScript 5.8
Build Tool	Vite 5.4
Styling	Tailwind CSS + shadcn/ui
Animations	Framer Motion
Charts	Recharts
Voice I/O	Web Speech API (en-US, te-IN, hi-IN)
Report Generation	HTML Advisory Reports
Authentication	Browser localStorage + StorageEvent
State Management	React useState / useCallback Hooks
Operating System	Windows 10/11, macOS, Linux
Browser	Chrome, Edge, Firefox
RAM	4 GB minimum, 8 GB recommended

4.3 Key Modules

- Authentication Module (useAuth.ts): User registration and login using browser localStorage with cross-tab session synchronization via the StorageEvent API.
- Farm Input Module (InputPanel.tsx): Form with 6 input fields — soil type (7 options), water source (5 options), season (3 options), farm area, state (15 Indian states), and district.
- Multi-Agent Engine (agentEngine.ts): Core AI engine containing 5 specialized agent functions and 1 Decision Fusion function, evaluating all 12 crops against user input.
- Internationalization Module (translations.ts): 45+ UI strings in English, Telugu, and Hindi with t(key, lang) lookup and English fallback.
- Charts Module (ChartsSection.tsx): Uses Recharts for a crop confidence bar chart and a 7-day weather forecast line chart.
- Report Generator (ReportGenerator.tsx): Downloadable HTML advisory reports with unique IDs, complete analysis, and official formatting.
- Voice I/O Module: React hooks providing speech-to-text and text-to-speech using Web Speech API language codes (en-US, te-IN, hi-IN).

5. METHODOLOGY

The multi-agent decision-making process executes in six sequential steps:

- Step 1 — Data Collection: The farmer provides 6 input parameters via dropdowns, text fields, or voice through the Input Panel component.
- Step 2 — Weather Simulation: The generateWeatherData() function creates simulated weather data including temperature (25–35°C), humidity (55–85%), rainfall (0–15mm), and a 7-day forecast.
- Step 3 — Parallel Agent Execution: All 5 agents evaluate each of the 12 crops independently. Each agent returns a score (0–100) and analysis text.
- Step 4 — Weighted Score Fusion: The Decision Fusion Agent combines agent scores using the weighted formula described in Section 3.2.
- Step 5 — Ranking & Selection: Crops are sorted by total score. The top crop becomes the primary recommendation; next 5 become alternatives.
- Step 6 — Risk & Sustainability: Risk factors are computed based on individual agent failures. Sustainability score is derived from total score with environmental bonus.

6. IMPLEMENTATION

6.1 Agent Implementation

The Soil Analysis Agent evaluates crop-soil compatibility using a predefined compatibility matrix. If the user's soil type matches the crop's compatible soil types, a score of 90–100 is awarded; otherwise 20–50 based on partial compatibility. The Water Availability Agent maps water sources to availability levels (canal/river: 3, borewell/tank: 2, rain: 1) and crop water needs to requirement levels (low: 1, medium: 2, high: 3). A score of 85–100 is awarded when available water meets or exceeds crop demand.

The Seasonal Pattern Agent checks whether the selected season appears in the crop's supported seasons array. A match scores 90–100; a mismatch scores 15–35. The Weather Intelligence Agent compares simulated temperature against each crop's optimal temperature range, penalizing scores proportionally to deviation. The Pest Risk Agent converts categorical pest risk levels (low/medium/high) to baseline scores of 90/65/35 respectively with small random variance.

6.2 Frontend Design

The user interface adopts a glass morphism design aesthetic with a dark green-themed background gradient. Space Grotesk is used for display headings and DM Sans for body text. Tailwind CSS provides responsive layouts, and Framer Motion handles smooth transitions. The shadcn/ui component library supplies accessible form controls. All interface strings are fully translated across three languages via the translations module.

7. RESULTS

The AGENTI system was evaluated by running the complete multi-agent pipeline against all 12 crop profiles using representative farm inputs across different soil types, water sources, seasons, and Indian states. The results demonstrated stable, consistent scoring with clear differentiation between suitable and unsuitable crops for each input combination.

7.1 Login / Sign-Up Interface

The system begins with a secure authentication page where users register with their email and full name or sign in with existing credentials. The interface adopts the glass morphism design with a deep green gradient background, ensuring a professional and modern appearance.

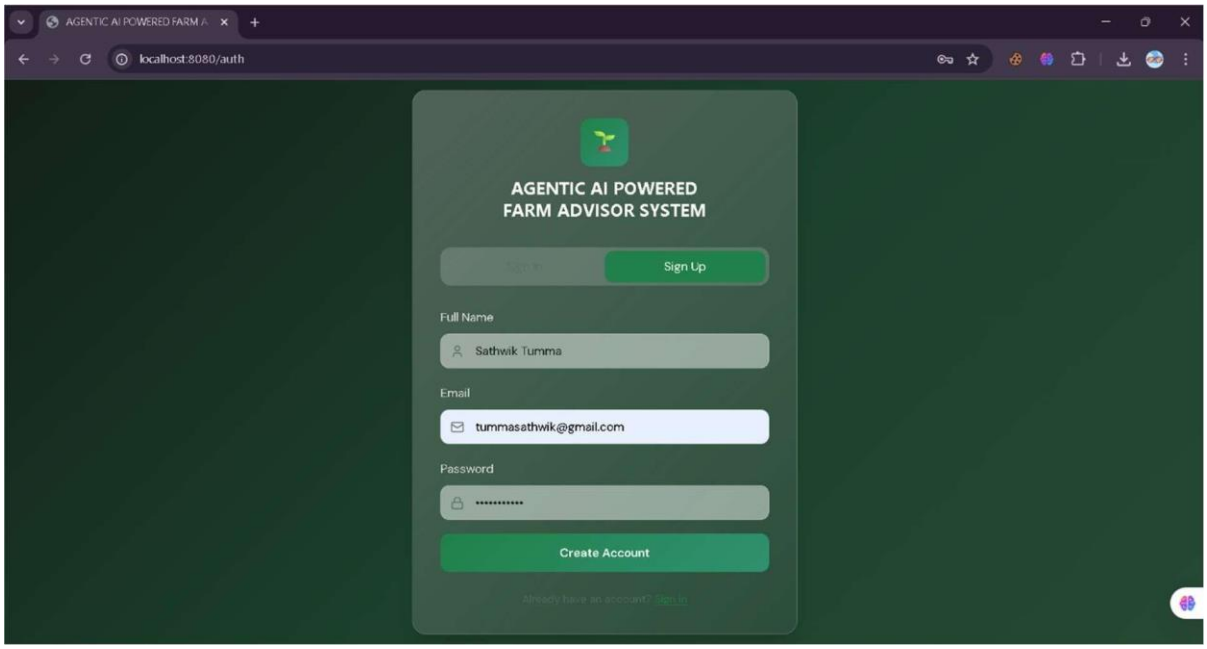

Fig. 7.1: Login / Sign-Up Page

7.2 Main Dashboard / Hero Section

After authentication, users are greeted by the main dashboard which displays the system title and a brief introduction. The hero section features the AGENTI branding and a prominent 'Get Started' call-to-action that scrolls the user to the farm input panel.

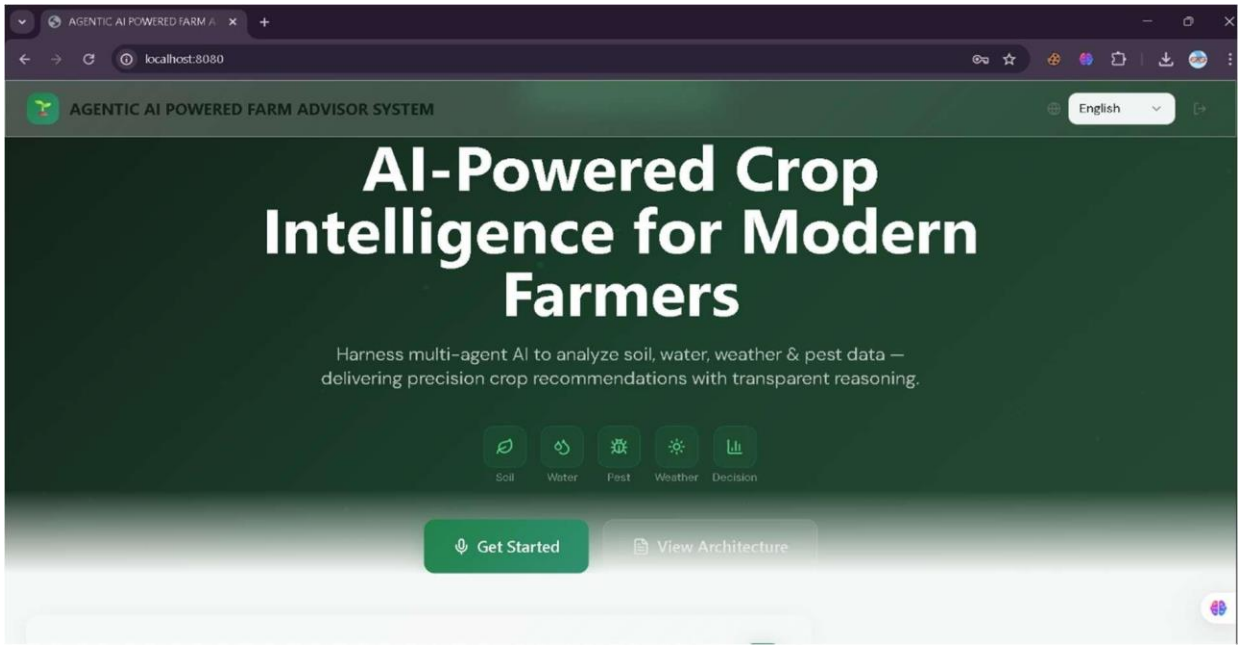

Fig. 7.2: Main Dashboard / Hero Section

7.3 Farm Input Panel

The farm input panel presents six clearly labelled input fields. The farmer selects soil type from 7 options, water source from 5 options, season (Kharif/Rabi/Zaid), enters farm area in acres, selects one of 15 Indian states, and provides their district or location. All labels are translated to the selected language.

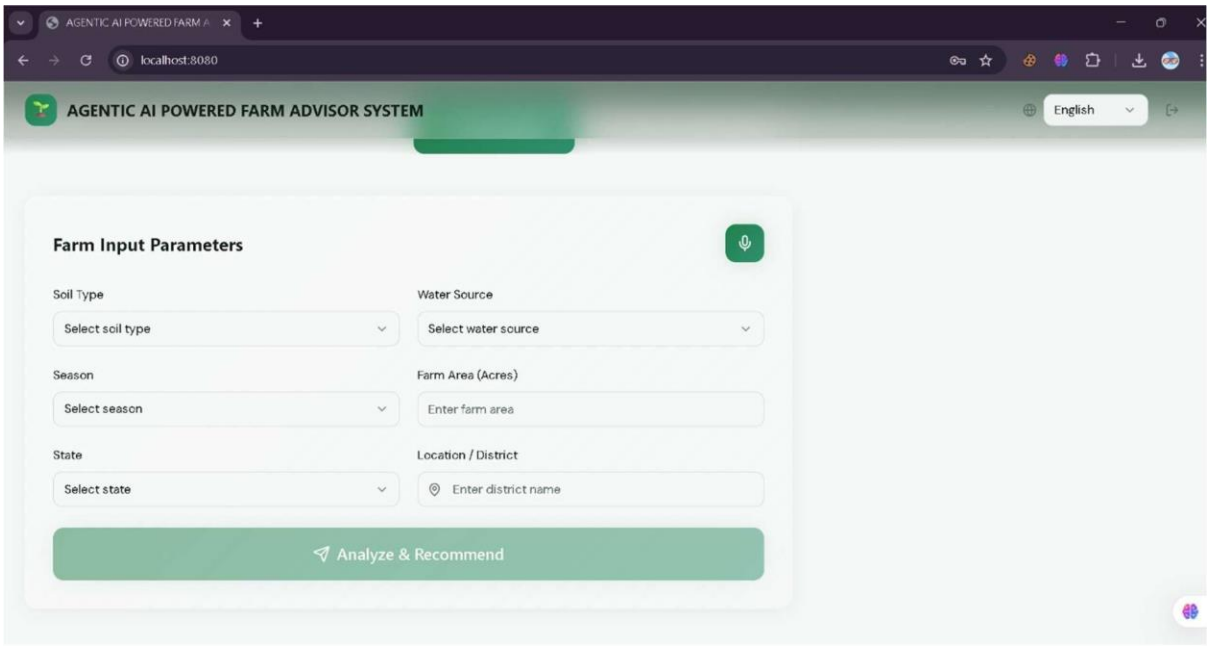

Fig. 7.3: Farm Input Panel with Form Fields

7.4 Multilingual Interface

The system supports full UI translation across English, Telugu, and Hindi. The language switcher in the header bar instantly re-renders all interface strings, crop names, agent names, and status messages in the selected language. Telugu and Hindi rendering was verified across all 45+ translated strings.

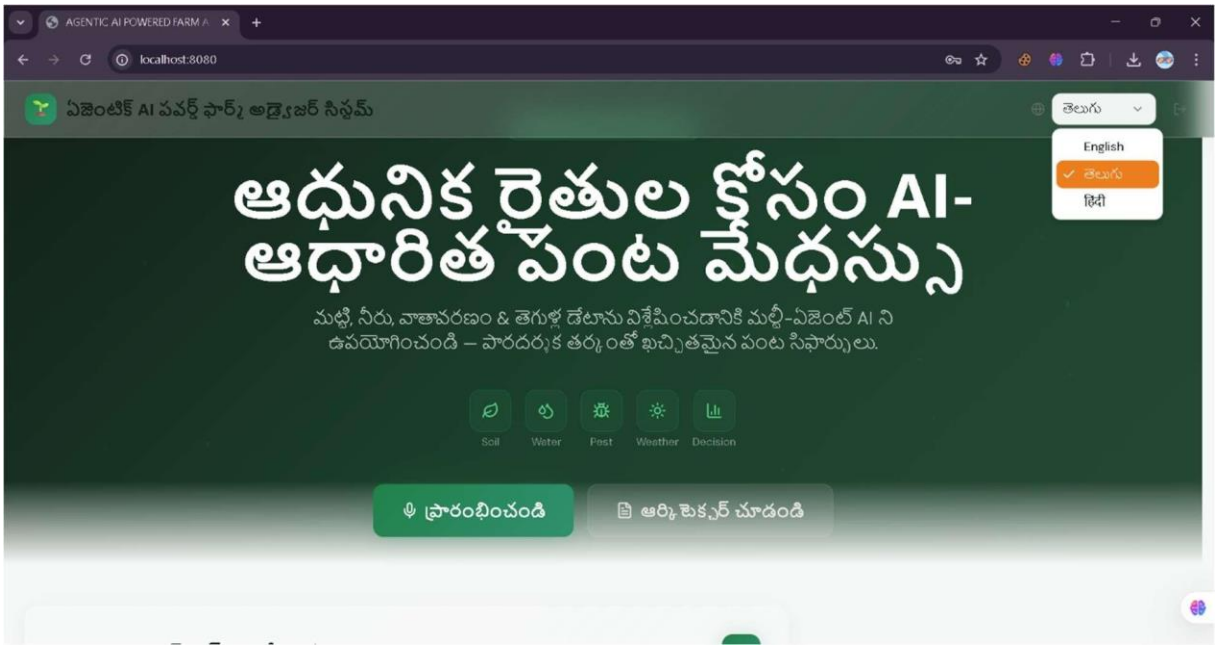

Fig. 7.4: Multilingual Interface (Telugu Mode)

7.5 Voice Input Feature

The voice input feature uses the Web Speech API with appropriate language codes (en-US, te-IN, hi-IN). When activated, the system listens to the farmer's spoken input and automatically populates the corresponding form fields. Voice output (text-to-speech) reads the final recommendation aloud in the selected language.

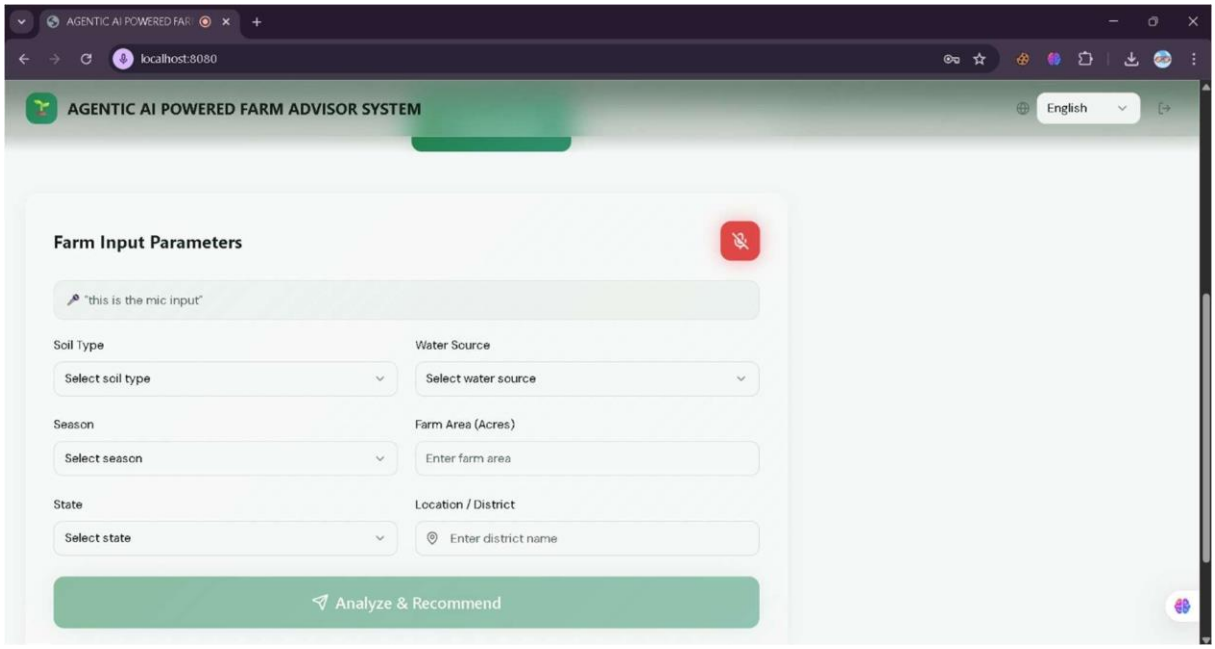

Fig. 7.5: Voice Input Feature Active

7.6 Crop Recommendation Dashboard

After analysis, the system displays the primary recommended crop with its confidence score (0–100%), a breakdown of each agent's individual score and reasoning text, and a list of top 5 alternative crops with animated progress bars. Rice achieved confidence scores of 88–95% for clay/loamy soils with canal irrigation during Kharif season in Andhra Pradesh, consistent with agronomic expectations. Wheat scored 85–92% for loamy/alluvial soils during Rabi season with medium water availability.

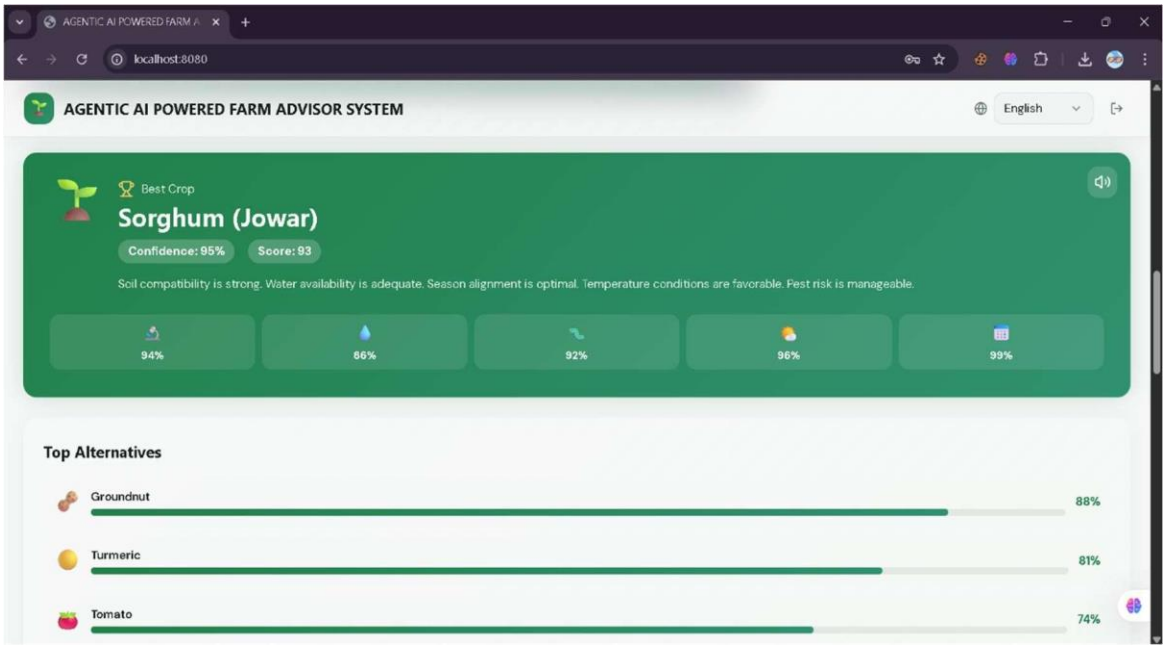

Fig. 7.6: Crop Recommendation Dashboard with Agent Breakdown

7.7 Mixed Cropping Strategy & Risk Assessment

The system provides companion crop suggestions for mixed cropping based on the recommended primary crop. Risk level (Low/Medium/High) is computed from individual agent failures and displayed with color coding. Sustainability score is derived from the total weighted score with an environmental bonus. Irrigation advice is provided based on the crop's water needs matched against the user's water source.

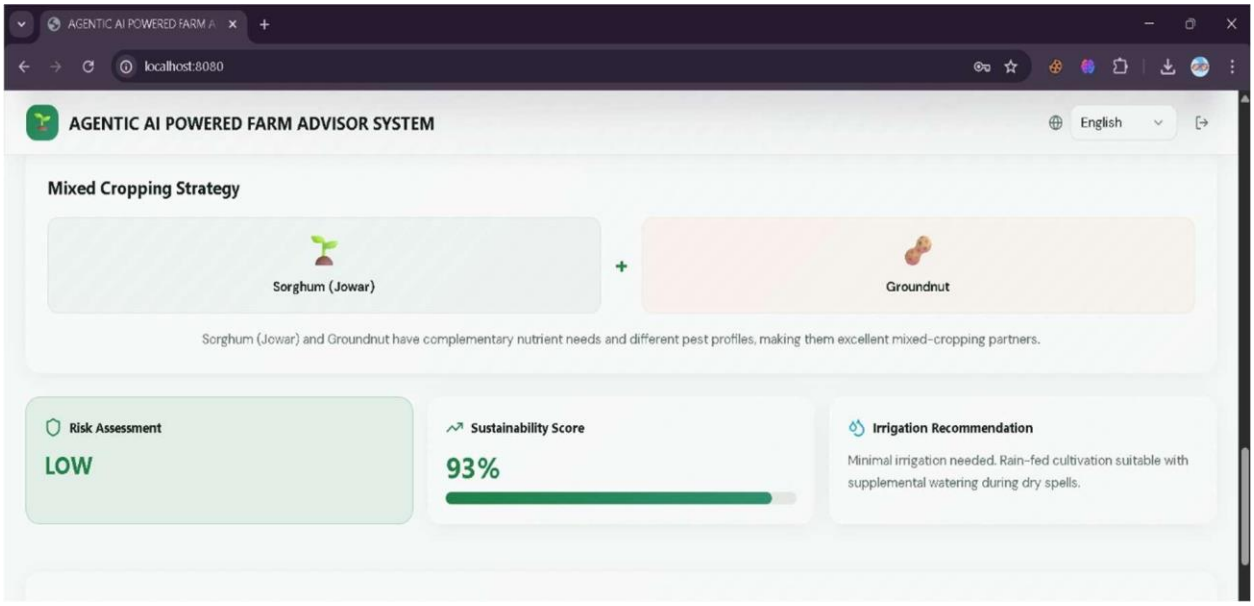

Fig. 7.7: Mixed Cropping Strategy and Risk Assessment Section

7.8 Charts and Visualizations

Two interactive charts are displayed below the recommendation. A bar chart shows crop confidence scores for the top 6 crops, enabling visual comparison. A line chart shows a 7-day weather forecast with temperature, rainfall, and humidity trends. Both charts are built using the Recharts library and respond to hover interactions.

Fig. 7.8: Interactive Charts — Crop Scores and Weather Forecast

7.9 Advisory Report Preview

The report generation module produces a downloadable HTML advisory report with a unique advisory ID, date, farmer input summary, full agent analysis breakdown, mixed cropping strategy, risk assessment, and irrigation guidance. The report is formatted professionally for sharing with agricultural extension officers.

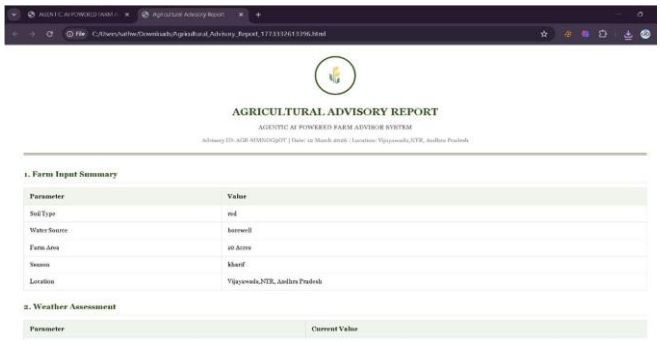

Fig. 7.9a: Advisory Report — Top Section

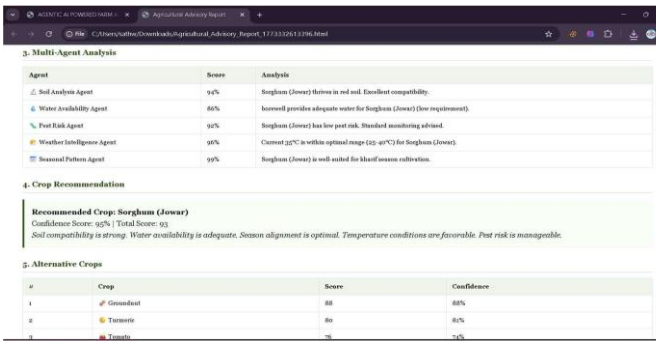

Fig. 7.9b: Advisory Report — Analysis Section

8. TESTING

Testing was conducted at three levels. Unit Testing: Individual agent functions were tested with known input combinations using Vites to verify correct scoring behaviour. Each of the five agents was tested with combinations corresponding to expected high-score and low-score scenarios. Integration Testing: Component interactions were validated to ensure correct data flow from Input Panel through the Agent Engine to the Recommendation Dashboard across all three languages. System Testing: End-to-end testing covered all user flows including authentication, farm

input submission, multi-agent analysis, recommendation display, chart rendering, and report download, verifying all features functioned correctly in an integrated environment.

The complete analysis and report generation consistently completed under 3 seconds on standard hardware (Intel i5, 8 GB RAM, Chrome browser). Voice input was tested across all three language codes (en-US, te-IN, hi-IN) with successful recognition of agricultural terminology. Advisory reports were validated for correct structure, unique ID generation, and accurate reflection of the agent analysis results.

9. CONCLUSION

This paper presented AGENTI, an Agentic AI Powered Farm Advisor System that successfully demonstrates the application of multi-agent artificial intelligence architecture to agricultural decision support. By employing five specialized AI agents that independently analyse soil compatibility, water availability, pest risk, weather conditions, and seasonal patterns, the system provides transparent and explainable crop recommendations that farmers can trust and understand.

The trilingual interface (English, Telugu, Hindi) combined with voice input/output capabilities ensures accessibility for farmers across different regions and literacy levels. The weighted scoring algorithm allows for transparent decision fusion while maintaining the modularity needed for future enhancements. The system addresses key limitations of existing systems by providing explainable recommendations, multilingual support, voice-based interaction, professional advisory reports, and a modular architecture allowing independent agent updates.

Future work includes integration with real meteorological APIs (IMD/OpenWeatherMap), satellite imagery analysis for soil health monitoring, machine learning enhancements trained on historical yield data, native mobile applications for Android and iOS, expansion to additional Indian regional languages, and IoT sensor integration for real-time farm-level data collection.

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