Agronomy App: A Web-Based Platform for Crop Recommendation and Agricultural Data Management

Bridging Technology and Sustainability in Smart Farming

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***Abstract*—Agricultural productivity is increasingly dependent on data-driven decision-making, yet many farmers and agronomists still rely on fragmented, manual record-keeping systems. This paper presents the Agronomy App, a full-stack web-based platform designed to digitize and streamline crop recommendation and agricultural data management. The system integrates a responsive frontend (HTML, CSS, JavaScript with Vite), a scalable backend (Node.js, Express), and a flexible NoSQL database (MongoDB) to support CRUD operations, real-time analytics, and modular expansion. The app addresses critical challenges such as data inaccessibility, inefficiency in tracking soil health and crop cycles, and lack of centralized reporting. Through design thinking methodology and user-centric development, the platform empowers stakeholders—including farmers, agricultural officers, and researchers—with intuitive dashboards, seasonal calendars, and market connectivity. The system's architecture supports future integration of AI models, IoT sensors, and weather APIs, positioning it as a scalable solution for smart farming. Empirical testing and survey analysis validate its usability, performance, and social impact.**

***Index Terms*—Agronomy, Crop Recommendation, Agricultural Informatics, MongoDB, Node.js, Smart Farming, Web Application, Sustainable Agriculture.**

I. INTRODUCTION

Agriculture forms the backbone of many developing nations, providing livelihoods to millions and sustaining economic growth. However, despite its importance, the sector continues to face persistent challenges such as unpredictable climatic variations, soil degradation, lack of awareness about scientific farming techniques, and unstable market conditions. Farmers often rely on traditional knowledge, which, while valuable, may not always align with modern agricultural demands and changing environmental patterns. The growing need for sustainable and data-driven farming practices has therefore created an urgent demand for intelligent technological interventions in agriculture.

With rapid advancements in artificial intelligence (AI), data analytics, and web technologies, the agriculture sector has witnessed a digital transformation. Integrating these technologies can offer personalized solutions to farmers by analyzing soil health, weather patterns, crop suitability, and market dynamics. The Agronomy platform was conceptualized as a response to this need — aiming to empower farmers with timely, data-backed decisions for effective crop management. The system provides a user-friendly digital ecosystem where farmers can access multiple tools, including crop recommendations, seasonal calendars, and market connectivity features, all from a single interface.

The primary objective of this research is to design, develop, and evaluate a web-based agronomy support system that enhances decision-making and bridges the gap between farmers, experts, and vendors. By leveraging AI-driven algorithms and user-centered design principles, the platform focuses on promoting precision agriculture and improving productivity. It emphasizes real-time crop recommendations based on environmental data, visual planning through seasonal calendars, and direct market interactions via the Market Connect module. The inclusion of these modules aims to foster transparency, accessibility, and sustainability within the agricultural value chain.

Furthermore, this study follows a design thinking methodology, emphasizing empathy, ideation, prototyping, and testing phases to ensure that the platform effectively addresses real-world farming challenges. Through continuous user feedback and expert evaluations, Agronomy-Assist demonstrates how technology can harmonize traditional agricultural wisdom with modern innovation. The outcome of this research not only supports individual farmers in optimizing their agricultural practices but also contributes to the broader goal of achieving sustainable food security and rural economic development.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The foundation of the Agronomy-Assist project lies in identifying the key challenges faced by farmers in managing crop production efficiently. A preliminary survey and literature review revealed that most farmers struggle with selecting the right crops for their soil and climate, accessing timely market information, and planning agricultural activities according to seasonal variations. These gaps in knowledge and accessibility often lead to reduced yields, financial losses, and unsustainable farming practices. Therefore, it became crucial to design a digital platform that could combine data-driven insights with user-friendly access to essential agricultural resources.

The research phase began by analysing existing agricultural platforms, mobile apps, and digital tools that offer advisory services to farmers. However, most available solutions were either limited to crop recommendation or market price listings, lacking an integrated approach. This insight led to the conceptualization of a unified system that could provide multi-faceted support—covering crop guidance, seasonal scheduling, and vendor-market connectivity—all under a single interface. The integration of these elements was aimed at empowering farmers with holistic decision-making capabilities.

To collect relevant data and design the system, multiple sources were consulted, including agricultural research papers, government farming portals, and local cooperative data. The team also conducted interviews with farmers and agricultural experts to understand practical challenges, cultural practices, and user preferences. This field-level engagement ensured that the system design remained grounded in real-world scenarios rather than theoretical assumptions.

The findings from this research and identification phase helped in defining the core objectives of the platform: to enhance crop selection accuracy, provide seasonal planning support, and build a networked ecosystem connecting farmers and vendors. These objectives became the driving force behind the subsequent design and development stages of the Agronomy-Assist syste

III. WRITE DOWN YOUR STUDIES AND FINDINGS

The design and development of the Agronomy and Crop Recommendation and Management System followed the Design Thinking approach, ensuring that the final product was empathetic, innovative, and user-centric. The process was executed through five key stages—Empathy, Define, Ideate, Prototype, and Test.

Empathy:
The Empathy phase focused on understanding the farmers' needs, pain points, and aspirations through direct interactions and field observations. Surveys and interviews were conducted with local farmers, agricultural officers, and crop vendors to gain deeper insights into their daily challenges. Farmers expressed difficulties in predicting seasonal crop patterns, identifying suitable crops for their region, and accessing reliable market connections. Many also faced technological barriers, lacking access to integrated platforms that could guide them through every stage of cultivation. These insights formed the emotional and practical foundation of the project, emphasizing the need for a solution that is both accessible and empowering.

Define:
In the Define phase, the gathered data was analyzed and categorized to define clear problem statements. The key issues identified were: lack of a structured decision-support system for crop recommendation, absence of a seasonal calendar that aligns planting and harvesting schedules with weather patterns, and limited connectivity between farmers and market vendors. These definitions provided clarity in the design direction, enabling the creation of well-targeted solutions. The goal was to bridge the gap between agricultural data and farmer usability through a digital, intuitive platform.

Ideate:
Brainstorming sessions identified the major solution components:

- AI-based Crop Recommendation System – Suggests the most suitable crops using soil, climate, and season data.
- Seasonal Calendar Module – Provides farmers with a month-wise guide for sowing, irrigation, and harvesting.
- Market Connect Platform – Connects farmers directly with vendors and buyers to ensure fair pricing and transparency.
- Smart Notification System – Sends timely alerts about irrigation schedules, fertilizer application, and harvesting.

Interactive Dashboard – Displays insights on crop health, productivity trends, and market statistics

Prototype:

In the prototype phase, the conceptual ideas were transformed into a functional model integrating the main modules—crop recommendation, seasonal calendar, and market connect. The user interface was designed with simplicity and accessibility in mind, ensuring ease of navigation for farmers. Backend services were developed using Node.js and MongoDB to handle data efficiently, while the frontend utilized React.js for dynamic rendering. The prototype allowed users to view crop suggestions based on real-time inputs, explore a detailed seasonal calendar for agricultural activities, and connect directly with market vendors. This working model served as the foundation for testing, refinement, and user feedback collection to enhance usability and performance.

Testing and Findings:

The testing phase focused on evaluating the functionality, usability, and performance of the developed system. The application was tested using both unit and integration testing to ensure seamless data flow between the frontend and backend. User acceptance testing was conducted with a group of farmers and agricultural experts to gather feedback on real-world usability. The results showed that the crop recommendation module provided accurate suggestions based on soil and climate data, while the seasonal calendar effectively guided farmers in scheduling their agricultural tasks. The market connect page successfully enabled vendor-farmer interactions, improving market accessibility. Overall, testing validated the system's reliability, accuracy, and user satisfaction, marking it as a practical solution for digital agriculture.

IV. GET PEER REVIEWED

After the initial development and testing phases, the project underwent a peer review process to ensure the validity, originality, and academic quality of the research. Experts from the domains of agriculture technology, artificial intelligence, and data science were invited to evaluate the methodology, design, and usability of the proposed system. The goal of the review was to identify gaps, validate the model's accuracy, and assess its practical implications for sustainable agriculture. Reviewers also focused on the clarity of objectives, data reliability, and the efficiency of the system's core functionalities, including the crop recommendation engine, seasonal calendar, and market connect platform.

During the review process, detailed discussions were conducted to evaluate how effectively the project addressed real-world agricultural challenges such as low yield prediction accuracy, limited farmer-market connectivity, and lack of region-specific seasonal insights. Peer reviewers appreciated the integration of advanced technologies like machine learning and real-time data analytics, noting that the system could bridge the gap between traditional farming practices and modern precision agriculture. Constructive criticism was provided regarding scalability, data security, and system adaptability for various regional conditions.

The reviewers also emphasized the importance of user experience, suggesting refinements in the interface for better accessibility, especially for farmers with limited technical knowledge. They recommended multilingual support and simplified navigation features to ensure inclusivity across diverse user groups. Feedback was also given on improving data visualization tools in the seasonal calendar to make information more intuitive and visually engaging.

Additionally, the reviewers encouraged expanding the market connect feature to include price forecasting and supply-demand analytics. This enhancement was suggested to help farmers make more informed marketing decisions, ensuring better profitability and reduced post-harvest losses. The collaborative nature of this peer review process not only enhanced the academic rigor of the study but also provided valuable insights that guided further development of the system.

Overall, the peer review phase played a crucial role in validating the research outcomes and improving the practical relevance of the project. It ensured that the system met both scientific and societal standards, contributing meaningfully to the advancement of agri-tech solutions. The feedback received from peers helped in refining technical details, optimizing user engagement, and strengthening the study's contribution to sustainable agricultural innovation.

Moreover, the reviewers emphasized the significance of the platform's contribution to modern agriculture through digital innovation. They suggested refinements in data visualization techniques to make insights more comprehensible to rural users, especially those with limited technological exposure. The peer review process also highlighted the importance of incorporating adaptive features for future scalability, such as integration with IoT-based sensors and advanced predictive analytics. By critically analyzing and addressing these insights, the project was further strengthened, ensuring that it aligns with both research excellence and practical implementation goals in the agricultural sector.

V. IMPROVEMENT AS PER REVIEWER COMMENTS

Based on feedback, we made the following enhancements:

1. Expanded sample scope from two districts to four agro-climatic zones to improve generalizability.
2. Added price forecast module: using historical mandi data and linear regression models to project next-month crop prices.
3. Enhanced UI contrast & localization: improved color contrast, added regional language toggles, font size adjustments.
4. Data validation: vendor profiles now require OTP-based contact verification to prevent fake listings.
5. Performance optimization: used caching, lazy loading, and reduced image sizes for low-bandwidth use.
6. Privacy & security improvements: encrypted stored user inputs, role-based access controls for vendors/farmers.

VI. CONCLUSION

In conclusion, the proposed agronomy-based digital platform successfully integrates advanced technologies such as artificial intelligence, data analytics, and web-based systems to assist farmers in making informed decisions about crop selection, seasonal planning, and market connectivity. The system's modular design — comprising the Crop Recommendation Page, Seasonal Calendar, and Market Connect Page — ensures a holistic approach to agricultural management. Through intelligent analysis of soil, weather, and crop data, the platform provides personalized insights that help improve yield efficiency and sustainability. The inclusion of real-time notifications and reminders enhances user engagement, ensuring timely farming operations aligned with seasonal variations.

Furthermore, the peer review and iterative improvement processes ensured that the project not only met technical standards but also addressed real-world agricultural challenges effectively. The integration of user-friendly interfaces, multilingual support, and responsive design makes the system accessible to farmers across diverse regions. Overall, the research contributes significantly to the digital transformation of agriculture by promoting data-driven decision-making, improving resource management, and strengthening the farmer-market linkage, paving the way toward a more sustainable and technology-empowered farming future.

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