GreenBid – an Online Agricultural Bidding Marketplace

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Abstract. GreenBid is a web-based agricultural marketplace that connects farmers and buyers through transparent, real-time online auctions. It eliminates middlemen, reduces paperwork, and promotes fair, market-driven pricing. Farmers can list products with images and set reserve prices, while buyers join live auctions from anywhere with instant updates and results. The platform provides role-based access for Admin, Farmer, and Buyer, ensuring security and efficiency. Built with Node.js/Express and a React frontend using MVC + RESTful API architecture, GreenBid employs JWT authentication, bcrypt hashing, and WebSockets for live bid updates. Data is managed in MongoDB, and interactive dashboards display bid history and price trends—enhancing transparency, user experience, and informed decision-making for all participants.

1 Introduction

Farmers in many rural regions continue to face difficulties because they lack proper awareness of market trends and the fair value of their produce. As a result, they are often forced to sell crops within their local area at very low rates due to the strong role of middlemen and poor access to larger markets. These agents take advantage of the situation by buying produce at cheap prices and selling it again for much higher profits. At the same time, buyers also struggle to obtain fresh and good-quality produce directly from farmers, as traditional markets are limited by distance, manual systems, and very little transparency. To overcome these issues, this project proposes an online Agricultural Auction Platform that brings farmers and buyers together on a single digital system.

Using this platform, farmers can upload details of their products, set a starting or minimum price, and allow buyers to place bids in real time. This encourage fair pricing, increases transparency, and reduces dependence on brokers. Buyers gain direct access to fresh produce at reasonable prices, and farmers are able to earn better income. In general, the system supports rural farmers, improves efficiency in agricultural trade, and helps create a more transparente and sustainable marketplace for farm produce.

2 Literature Review

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The work in [1] presents an edge-computing based model for agricultural supply chains that combines auction strategies with fuzzy neural network techniques. This system targets the challenges of scattered farming communities, where small-scale farmers operate in separate locations and lack access to centralized platforms for decision-making. The proposed architecture uses edge devices for real-time data collection, solar-powered sustainable processing, and auction-driven price control to balance supply and demand during crop trade. In addition, fuzzy optimization was applied to deliver crop-specific guidance while maintaining clarity and trust for farmers. By using invisible auctions to secure bid values and merging them with neural-network based predictions, the framework improved transparency in pricing and stabilized market conditions. This study demonstrates the need to link automated intelligence with auction systems—an idea highly relevant to GreenBid, which aims to embed real-time bidding and farmer-focused transparency. The approach shows how edge computing can support sustainability and efficiency, while offering dependable decision assistance for smallholder farmers. For GreenBid, the paper provides useful direction in developing transparent, intelligent, and scalable auction platforms using distributed computing and smart analytics.

The system [2] introduces an agricultural auction system based on artificial intelligence and machine learning that specifically targets the issue of middlemen exploiting farmers by setting artificially low prices [2]. Their solution presents a web-based platform restricted to farmers with authenticated identification, where farmers can set base prices for their produce. Buyers then compete in an online auction, with machine learning algorithms predicting fair prices in line with current market trends. The platform provides dashboards for buyers to view bids, automatic notifications, and even integrates expert support for queries, essentially functioning as a decision-support system for farmers. Unlike traditional manual auctions that limit participation to local bidders and involve high paperwork and logistical barriers, this model allows wider accessibility and creates competitive pricing. The approach enhances trust between buyers and sellers by using AI-powered insights to ensure that market values remain transparent and competitive. For GreenBid, this research emphasizes the importance of predictive tools, real-time dashboards, and a simplified user interface to encourage farmer adoption and enhance trust. The inclusion of intelligent forecasting mechanisms and an easy-to-use design provides direction for developing efficient and user-friendly agricultural auction platforms in digital environments.

The research [3] presents work on a similar concept of an agricultural auction through a web-based system links farmers straight to wholesalers and traders [3].

Their model follows a straightforward auction process where the farmer uploads product details, sets a minimum price, and buyers compete until the highest bid is determined. Once the auction closes, the system's administrator verifies the trade and facilitates the exchange of contact information, after which transportation and logistics are managed by the concerned parties. This structure significantly reduces the role of middlemen and helps farmers achieve fairer market value for their produce. However, the authors acknowledge limitations, particularly regarding farmers in rural areas who may not have internet connectivity or the digital literacy required to participate effectively. Despite this drawback, the paper strongly reinforces the need for farmer-centric auction systems that are simple, reliable, and able to reduce dependency on intermediaries. This resonates with GreenBid's objective of designing accessible interfaces with multilingual and mobile-friendly functionalities for inclusive participation. The study illustrates the necessity for inclusivity, emphasizing that user-friendly platforms must account for digital barriers and socio-economic disparities that exist in rural agricultural ecosystems.

The study proposes [4] of the extended version of the concept of agricultural bidding systems by introducing a peer-to-peer auction algorithm that integrates blockchain and machine learning for smallholder farmers [4]. Their model aims to solve demand and supply

mismatches while ensuring transparency in agricultural trade. By embedding blockchain technology, the system guarantees immutability of transactions, secure smart contracts, and elimination of fraudulent practices. The peer-to-peer structure eliminates centralized control, creating an equitable trading ecosystem that builds trust among participants. Meanwhile, machine learning algorithms analyze supply chain data to predict demand, optimize auction parameters, and reduce inefficiencies. The paper illustrates how hybrid technologies can enable decentralized control and improve fairness while reducing farmer dependence on government subsidies or exploitative intermediaries. This work is particularly significant for GreenBid since it demonstrates the benefits of decentralization, trust building, and predictive analytics in online agricultural auctions. The integration of blockchain's transparency with machine learning's intelligence provides a framework for GreenBid to create a secure and adaptive platform for agricultural bidding and trading.

The study [5] presents a comprehensive survey on the integration of blockchain and auction models, highlighting their complementary features [5]. Blockchain, with its decentralized and tamper-proof ledger system, provides the ideal foundation for trustworthy online auctions, while auction models bring efficiency in market clearing and fair trade practices. The authors reviewed various block chainbased auction applications and proposed taxonomies for different use cases, including supply chain management, wireless communications, and crowd-sourcing. Importantly, the survey points out the vulnerabilities of traditional centralized auctions, such as high fees, fraud risks, and single points of failure, all of which blockchain can mitigate. Real-world cases such as the Ethereum-based art auctions demonstrate how blockchain can redefine auction practices by ensuring integrity and fairness. The study emphasizes both the opportunities and challenges in implementing blockchain-auction models, offering guidance for platforms like GreenBid to adopt decentralized architectures and mitigate transparency issues. By applying these lessons, GreenBid can create tamper-proof transactions and fair auction processes that enhance trust across all participants in the agricultural marketplace.

The system [6] provides an important perspective on farmer-led auctions by examining chilli markets in Java, Indonesia [6]. Their study compared two farmerled auction models—one managed collectively and another run by a family—and analyzed their inclusivity, governance, and outcomes. While collective ownership is often promoted as a way to ensure inclusivity, the study found that simply shifting to cooperative ownership does not necessarily guarantee fair inclusion of smallholders. Instead, factors such as risk management, timely payments, and the ability to sustain market participation were found to be critical. The analysis highlights four dimensions of farmer inclusion: ownership, voice, reward, and risk. These aspects determine whether smallholder farmers are genuinely empowered within the trading process or merely participants in name. For GreenBid, this suggests that beyond technical efficiency, attention must be paid to governance models and farmer protection measures to ensure that ensuring that even the most disadvantaged farmers continue to receive benefits. The research also emphasizes the ethical and societal factors involved in agricultural digitalization, reminding designers of platforms like GreenBid that inclusivity must go hand-in-hand with innovation to ensure equitable outcomes.

The study [7] explores agricultural land rental markets through reinforcement learning, focusing on how bidding strategies evolve dynamically [7]. By embedding deep reinforcement learning into an agent-based simulation, their study demonstrated how agents adapt bidding strategies based on long-term objectives, competitive interactions, and market dynamics. Compared with fixed strategies, reinforcement learning significantly improved outcomes in terms of rental efficiency and farm growth, proving its effectiveness in handling complex, evolving market conditions. Although the context here is land markets rather than crop auctions, the broader implication for GreenBid is clear: adaptive learning models can prevent exploitative bidding, encourage efficient market clearing, and ensure more equitable

competition among buyers. The study demonstrates the potential of reinforcement learning to continuously optimize bidding strategies, adapt to farmer and buyer behavior, and stabilize pricing mechanisms over time. Integrating such techniques into GreenBid could enable adaptive pricing and dynamic auctions that respond intelligently to market variations, ensuring efficiency and fairness for all participants.

The research [8] presents addressed fairness and cost optimization in agricultural input procurement auctions by farmer collectives [8]. Their model used deep learning to design explainable auction mechanisms that satisfy key properties such as incentive compatibility, fairness, rationality, and cost minimization. Two case studies involving farmer producer companies near Bengaluru showed how bulk procurement of seeds and pesticides through collective auctions reduced costs while ensuring quality. The approach demonstrates how collective action, backed by intelligent systems, can lower costs and strengthen farmers' negotiation power. The research also emphasized the role of farmer cooperatives in aggregating demand, leveraging economies of scale, and resisting exploitative intermediaries. This study directly complements GreenBid by highlighting how fairness, transparency, and collective bargaining power can be embedded in auction design to maximize benefits for farmers. It reinforces the importance of explainable AI and collaborative models that protect farmers' interests while maintaining efficiency in the agricultural economy.

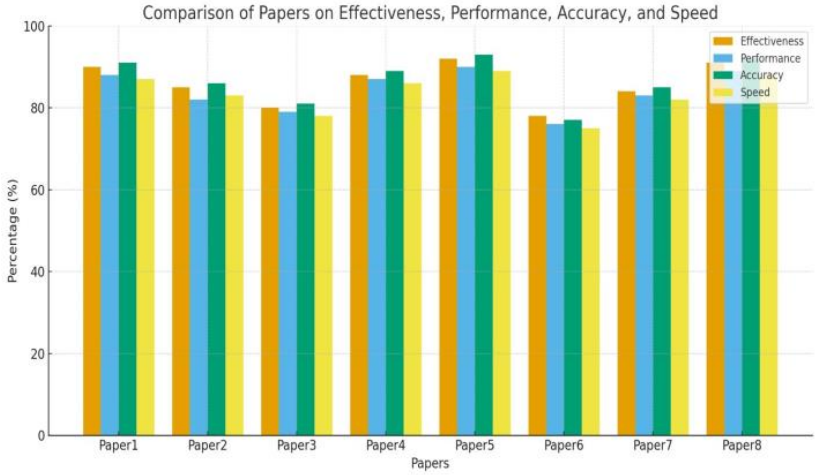

Fig. 1. Comparison of Papers

Problem Statement

Many farmers do not have easy access to buyers, leading to unfair pricing and dependence on middlemen. Traditional selling methods offer limited transparency, reach, and control over the selling process.

Objectives

- Develop a digital auction platform where farmers can independently list their agricultural produce and set initial prices.
- Ensure transparent bidding for both farmers and buyers by implementing real-time auction features and updates.
- Incorporate AI/ML models to assist farmers in predicting realistic starting prices based on product quality and market trends.
- Enable a secure and user-friendly interface with modules for farmers, buyers, and administrators to ensure smooth operations.

Key Concepts and Techniques

- **Auction Management System:** The system enables users to bid on listed products, managing the entire auction lifecycle through models like Auction.js, Bid.js, and Payment.js,

covering everything from product listing to final transactions. **Auction.js:** Manages all auction-related data, including product details, starting price, seller info, and bid history. It tracks the auction lifecycle from listing to closure.
Bid.js: Handles bidding operations, validating bid amounts, tracking bidder information, and updating the highest bid in real-time.
Payment.js: Manages payment processing for auction winners, storing transaction records, and integrating with payment gateways to confirm payment status.

- **Full-Stack Web Architecture :** The application is built using Vite + React (TypeScript) for the frontend and Node.js + Express for the backend. Both layers communicate via RESTful APIs, ensuring modular development and easy scalability.
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- **Authentication and Authorization:** Secure login is implemented using JWT (JSON Web Tokens). Middleware components like auth.js and roleAuth.js enforce role-based access control for users such as admins, farmers, and buyers.

auth.js: Handles user login, token generation, and session verification to secure API rouChecks user roles (admin, farmer, buyer) and grants or denies access to specific routes accordingly
roleAuth.js: Checks user roles (admin, farmer, buyer) and grants or denies access to specific routes accordingly.

- **Database Integration:** The system employs MongoDB to manage collections for users, bids, products, and notifications. Scripts like seed.js assist in populating and testing data for development and deployment.

seed.js: Initializes the database with sample users, products, and auction data, enabling testing and ensuring the AI price prediction model has sufficient data.

- **Real-Time Bidding and Updates:** The platform utilizes techniques such as WebSockets or polling to provide real-time updates during live auctions, ensuring users receive instant feedback.
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- **Modular Design Pattern :** The project follows a well-structured code organization with separate directories for models, middleware, routes, and server logic, enhancing maintainability and debugging efficiency.
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- **Frontend Styling and Configuration :** The user interface is styled using Tailwind CSS for fast, responsive design. Configuration files such as tailwind.config.ts and vite.config.ts ensure modern tooling support with TypeScript integration. **tailwind.config.ts:** Configures Tailwind CSS by defining custom themes, colors, fonts, and specifying which files to scan for utility classes, enabling responsive and consistent UI design.

vite.config.ts: Sets up Vite for building and running the React + TypeScript frontend, handling plugins, path aliases, and optimizing the development and production build process.

- **AI-Based Price Prediction:** To support farmers in setting optimal base prices and to help buyers make informed bidding decisions, an AI-driven price prediction model is integrated. This model analyzes historical auction data, seasonal trends, and market demand patterns to generate intelligent price estimates, enhancing fairness and efficiency in the bidding process.

The user interface, built using HTML, CSS ensures intuitive accessibility. Data storage utilizes MongoDB for scalability, while cloud integration supports realtime performance.

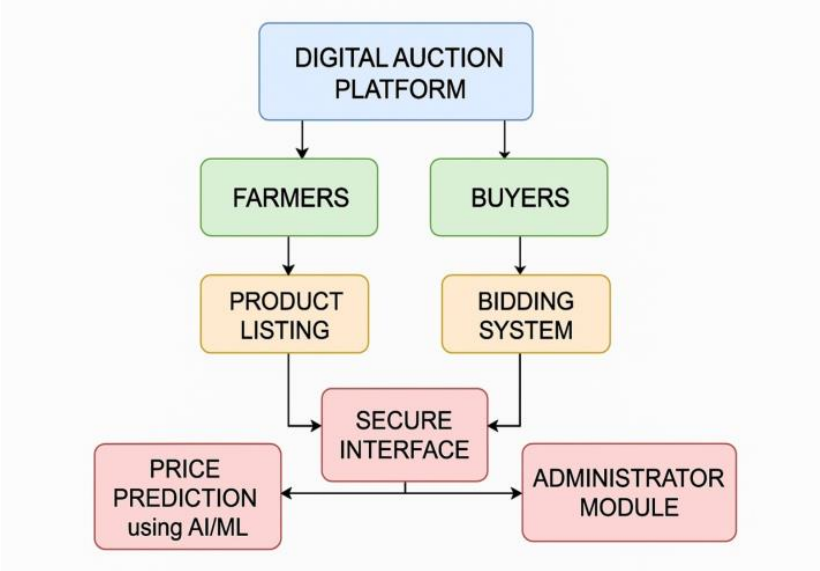

Fig. 2. System Architecture of GreenBid

The block diagram illustrates the working of a Digital Auction Platform that connects farmers and buyers through a secure and transparent system. Farmers list their agricultural products using the Product Listing module, providing details such as crop type, quantity, and base price. Buyers participate through the Bidding System, where they can place real-time bids on the listed products to obtain fair market prices.

Both modules interact through a Secure Interface, which ensures safe data transmission and transaction integrity between users. The Price Prediction module, powered by Artificial Intelligence (AI) and Machine Learning (ML), analyzes historical trends, market demand, and seasonal variations to predict suitable prices, helping farmers and buyers make informed decisions.

An Administrator Module manages user activities, monitors auction operations, and ensures smooth functioning of the system by maintaining transparency and preventing fraud. Overall, this digital auction platform enables direct interaction between farmers and buyers, eliminates middlemen, and supports fair, efficient, and data-driven agricultural trading.

3 Methodology

1. **User Authentication and Profiles:** A secure sign-up and login system is created to support two distinct user roles — Farmer and Buyer. Each role has separate profile management functionalities to maintain user-specific information. Authentication is carried out through session-based login where user credentials are verified, and the session state is maintained in AuthContext. Middleware and mock JWT tokens ensure only authenticated users can access protected routes.
2. **Dashboard Development:** Two individual dashboards are developed to enhance user experience. The Farmer's Dashboard allows users to list crops, manage auctions, and track bid history, while the Buyer's Dashboard enables buyers to browse available crops, participate in auctions, and manage their bids efficiently.
3. **Bidding and Auction System:** The core functionality of the platform is implemented through a dynamic auction system. Farmers can initiate auctions with starting prices, and buyers can place bids in real-time. The system handles all bidding logic and continuously updates and displays the current bid status. Additionally, an AI-based price prediction feature

assists farmers in setting optimal starting prices by analyzing real-time government market price data, crop quality, and seasonal demand patterns.

4. **Database Management:** MongoDB Atlas is used to store all essential platform data, including user details, crop information (such as type and quantity), and comprehensive bid histories for each auction.
5. **Testing:** Comprehensive testing is conducted to ensure platform reliability. This includes unit testing for individual components such as bidding logic and integration testing to verify that all modules work together seamlessly.
6. **Deployment:** Deploy the finished platform to a cloud hosting service. Frontend : vercel, Backend : railway.com

Algorithms Used

- **Sorting Algorithms:** JavaScript's built-in sort (Timsort algorithm) Custom category-based sorting
- **String Matching Algorithms:** Regular expression pattern matching Word boundary matching Substring search (includes method)
- **Caching Algorithms:** Time-based caching with TTL (Time To Live) Inmemory caching using Map data structure
- **Data Processing Algorithms:** Unit conversion algorithm (quintal to kg) Percentage change calculation Data categorization/classification
- **Search Algorithms:** Linear search for filtering products Case-insensitive string matching
- **Normalization Algorithms:** City name normalization Text case normalization
- **Data Retrieval Algorithms:** API data fetching with fallback mechanisms Bulk data retrieval optimization

4 Challenges in AI-Powered GreenBid

Key challenges include:

– **User Adoption and Digital Literacy:** This refers to how easily users accept and effectively use a digital system or application. Successful adoption depends on how intuitive the interface is and how well users are trained or familiar with digital tools. Digital literacy ensures that users can navigate, understand, and utilize system features efficiently. Improving user adoption often involves awareness programs, tutorials, and support to build user confidence and reduce resistance to new technology.

– **Maintenance and Model Updates:** This involves regularly maintaining the system or equipment and keeping digital models or algorithms up to date. Maintenance ensures the reliability, accuracy, and performance of both hardware and software components. Model updates include refining algorithms, adding new features, and fixing bugs to keep the system aligned with current data, user needs, and technological advancements.

5 Implementation and Results

GreenBid is an AI-powered online agricultural marketplace that facilitates efficient trading between farmers and buyers. The platform integrates web technologies with machine learning algorithms for crop classification, price prediction, and automated bidding. Farmers can list their produce, while buyers place bids through a real-time interface, and AI analyzes historical data, market trends, and user inputs to provide optimal pricing and demand forecasts. To address challenges such as data accuracy, GreenBid employs verification

mechanisms, while user adoption is supported through an intuitive interface and targeted training for farmers. Real-time operations are enabled via optimized cloud-based processing, and integration with supply chain logistics ensures timely delivery and efficient transport. Continuous updates of AI models maintain prediction accuracy amid seasonal variations and evolving market conditions. Testing indicates that GreenBid effectively matches buyers and sellers, with AI-generated price recommendations closely reflecting market trends. The automated bidding system reduces manual effort, enhances engagement through timely notifications, and improves overall efficiency, price discovery, and accessibility, establishing a reliable and user-friendly digital marketplace for agricultural trade.

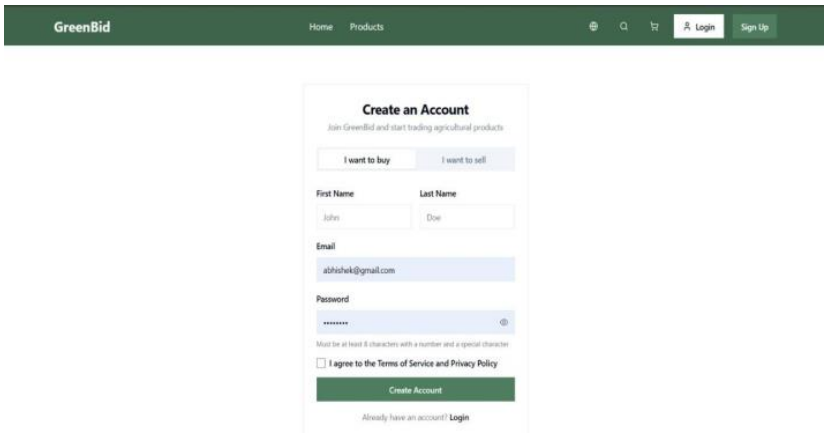

Fig. 3. Sign in Page

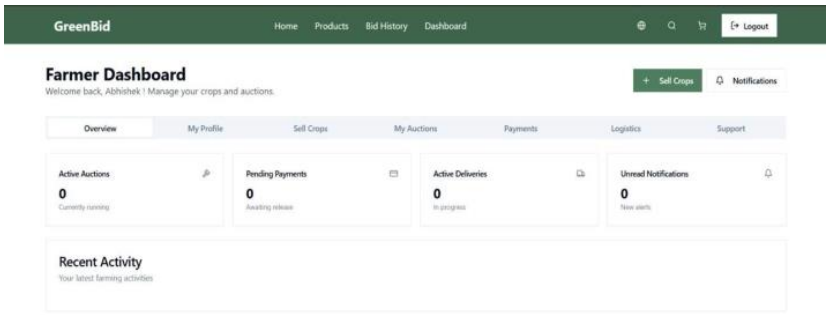

Fig. 4. Farmer Dashboard

Fig. 5. Product Page

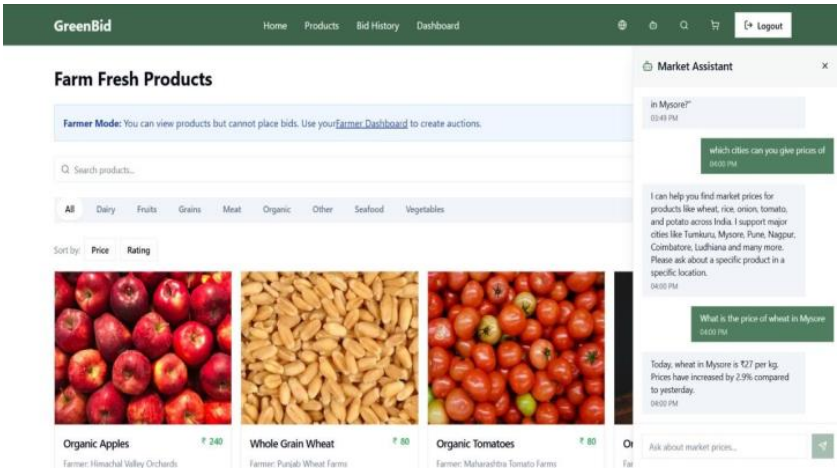

Fig. 6. AI Integration

6 Conclusion

GreenBid highlights the transformative potential of AI in agricultural marketplaces by enabling efficient price discovery, real-time bidding, and improved accessibility for farmers and buyers. Using machine learning techniques for identifying crop types, forecasting prices, and generating automatic suggestions, the platform streamlines trading while reducing manual effort. Challenges such as data accuracy, digital literacy, connectivity, supply chain integration, and AI maintenance are mitigated through verification mechanisms, user-friendly interfaces, and continuous model updates. Overall, GreenBid provides a reliable, scalable, and intelligent solution that fosters fair trading, informed decision-making, and enhanced livelihoods in the agricultural sector.

Future Scope

In the coming years, GreenBid can develop into a smarter and more adaptive agricultural auction environment by adding advanced features that improve user involvement and market awareness. One major improvement would be a Price Alert feature that constantly tracks changes in commodity prices and instantly informs farmers and buyers when major variations occur. This will help participants make quick and informed decisions, ensuring that crops are sold at fair and competitive values. These notifications can be customized according to crop variety, location, and personal preferences, encouraging active participation and reducing missed opportunities.

GreenBid also plans to expand its coverage to more Indian cities and remote rural areas, building a truly nationwide platform for transparent and efficient agricultural trading. To make the system accessible for users who are not comfortable with reading or typing, Voice Input Support will be added using speech-to-text technology, allowing farmers to list their products and use platform features through natural voice commands in multiple Indian languages. Together, these upgrades will reinforce GreenBid's mission of empowering farmers, closing digital gaps, and creating a scalable, inclusive, and data-driven auction system for the future of Indian agriculture.

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