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Digital Green Market: Connecting Farmers and Consumers

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Abstract: The agricultural supply chain in India is largely dependent on multiple intermediaries, resulting in reduced profits for farmers and increased prices for consumers. Traditional mandi systems and retail chains often lack transparency, direct interaction, and price control for primary producers. To address these limitations, this paper presents Digital Green Market, a Farmer-to-Consumer (F2C) real-time web marketplace platform that enables direct digital trade between farmers and consumers. The system eliminates unnecessary intermediaries and provides a transparent, role-based, and scalable e- commerce environment for agricultural products. The platform supports multiple user roles including Farmers, Consumers, Bulk Buyers, and Admin, with features such as product listing, geolocation-based discovery, tiered product visibility, multilingual interface, OTP-based authentication, order tracking, and analytics dashboards. The system is implemented using a full-stack architecture with Next.js and React.js for the frontend, Node.js and Express.js for backend services, and MongoDB for persistent data storage. Testing results demonstrate improved accessibility, reduced supply chain friction, and better price fairness. The Digital Green Market platform serves as a scalable and practical solution for modernizing agricultural commerce through technology.

Keywords: *Farmer-to-Consumer, Agricultural E-Commerce, Direct Market Platform, Supply Chain Digitization, Full-Stack Web Application.*

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I. INTRODUCTION

Agriculture remains a foundational pillar of the Indian economy, yet the agricultural marketing ecosystem continues to face inefficiencies due to fragmented supply chains and excessive intermediary involvement. Farmers are often forced to sell their produce at low prices to middlemen, while consumers pay significantly higher prices by the time products reach retail markets. This disconnect leads to reduced farmer income, higher consumer cost, and increased post-harvest losses.

With the rapid growth of digital technologies and web-based commerce platforms, there is an opportunity to transform agricultural trade through direct market connectivity. A Farmer-to- Consumer (F2C) digital marketplace can bridge the gap between producers and buyers, ensuring transparency, fairness, and efficiency.

To address this need, Digital Green Market is proposed as a unified web platform that directly connects farmers and consumers. The system enables farmers to list products, set prices, and manage orders, while consumers and bulk buyers can discover nearby produce, place orders, and track deliveries. The platform integrates authentication, role-based access control, geofenced product discovery, and multilingual usability to ensure accessibility across diverse user groups.

The primary objective of the platform is to simplify agricultural commerce, empower farmers with digital control, and provide consumers with fresh produce at fair prices.

II. RELATED WORK

Several digital initiatives and research efforts have attempted to improve agricultural marketing through technology. Government-supported mandi digitization systems and e-NAM platforms provide electronic auction mechanisms, but they still rely heavily on intermediaries and institutional control structures.

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Research on agricultural e-commerce growth highlights increasing adoption of digital trade platforms, but many studies focus on macro-level trends rather than implementable technical frameworks. Survey-based studies on farmer perception indicate a need for simpler interfaces, direct pricing control, and localized digital tools.

Prototype Farmer-to-Consumer platforms have been proposed in academic literature; however, many remain at conceptual or small-scale levels without scalable architecture, role-based access control, or secure authentication mechanisms. Industry articles describe startup-driven farm-to- market models but lack formal system design and implementation details.

Unlike prior approaches, the Digital Green Market platform provides a complete full-stack implementation with multi-role architecture, geolocation filtering, OTP authentication, and tiered product visibility, making it suitable for scalable deployment.

III. PROBLEM STATEMENT AND OBJECTIVES

➢ *Problem Statement*

The existing agricultural supply chain is heavily dependent on multiple intermediaries, which reduces farmer profits and increases consumer prices. Farmers often lack direct access to customers and are forced to accept market prices set by middle agents. There is no reliable real- time price transparency, leading to information gaps and unfair trade practices. Small farmers have limited market reach and cannot easily connect with a broader customer base. Indirect distribution and repeated handling also result in high post-harvest losses for perishable goods. Current digital systems are either complex or not tailored for small-scale farmers. Therefore, a structured and user-friendly Farmer-to-Consumer (F2C) digital marketplace is required.

➢ *Proposed System and Objective*

The proposed system, F2C Digital Market, is a unified real-time web marketplace platform designed to directly connect farmers with consumers and bulk buyers. It replaces the traditional intermediary-driven supply chain with a structured digital platform that enables direct product listing, discovery, and ordering. Farmers are provided with a dedicated dashboard to manage products, pricing, and stock, giving them full control over their sales operations. Consumers can browse nearby farm products using geolocation-based discovery and place orders through a simple interface. The platform supports multiple user roles including Farmer, Consumer, Bulk Buyer, and Admin with role- based access control. Secure OTP-based authentication is implemented to ensure safe and verified user registration and login. The system also includes multilingual and mobile-friendly design to improve accessibility for diverse users. Order tracking and dashboard analytics features enhance transparency and operational visibility. The overall objective is to build a scalable, secure, and farmer-centric F2C marketplace that improves income fairness and reduces supply chain inefficiencies.

- The proposed F2C Digital Market system provides a unified real-time web platform that directly connects farmers with consumers and bulk buyers.
- It eliminates unnecessary intermediaries by enabling direct product listing and direct purchase workflows.
- The platform allows farmers to manage product details, pricing, and inventory through a dedicated and simple dashboard.
- It supports geolocation-based product discovery so consumers can find and purchase from nearby farmers.
- The system implements multi-role access control for Farmers, Consumers, Bulk Buyers, and Admin users.
- Secure OTP-based authentication and token-based session management are used to ensure safe user registration and login.
- The interface is designed to be multilingual and mobile-friendly to improve accessibility and usability.
- The platform includes order tracking and dashboard analytics to provide transparency and operational insights for users.

IV. SYSTEM ARCHITECTURE AND DESIGN

➢ *Presentation Layer*

The Presentation Layer represents the frontend of the F2C Digital Market platform and is developed using Next.js and React.js to provide a fast and interactive user experience. It delivers a responsive user interface that works across desktop and mobile devices. This layer includes role-based dashboards for Farmers, Consumers, Bulk Buyers, and Admin users, ensuring customized views and actions. It also supports a multilingual interface to improve accessibility for users from different language backgrounds.

➢ *Application Layer*

The Application Layer forms the backend of the system and is implemented using Node.js and Express.js to handle business logic and request processing. It exposes REST API services that manage authentication, product operations, orders, and user actions. JWT-based authentication is used to secure sessions and verify user identity across requests. Role-based authorization middleware ensures that each user can access only the resources and operations permitted for their role.

➢ *Data Layer*

The Data Layer is responsible for persistent storage and data management and is implemented using MongoDB Atlas as a cloud-based NoSQL database. It stores structured collections such as Users, Products, Orders, and Order Items to support marketplace operations. Schema validation rules are applied to maintain data integrity and prevent invalid records. Indexing and optimized queries are used to improve performance and ensure faster data retrieval for large datasets.

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➢ *User Roles*

- Farmer — Farmers can create and manage their profiles, add or update product listings, set prices and stock levels, and view and update incoming order statuses.
- Consumer — Consumers can browse nearby products, view details, add items to cart, place orders, and track their order history and status.
- Bulk Buyer — Bulk Buyers are verified users who can access wholesale product listings and place high-quantity orders at bulk pricing.
- Admin — Admin users monitor the platform, verify bulk buyers and farmer accounts, moderate listings, and manage overall system control functions.

➢ *System Models and Architectural Views*

- *System Architecture*

The "Digital Green Market" is built upon a 3-Tier Architecture, a well-established and robust model for modern web applications. This architecture decouples the application into logical layers, which significantly improves scalability, maintainability, and the ability to develop the frontend and backend independently.

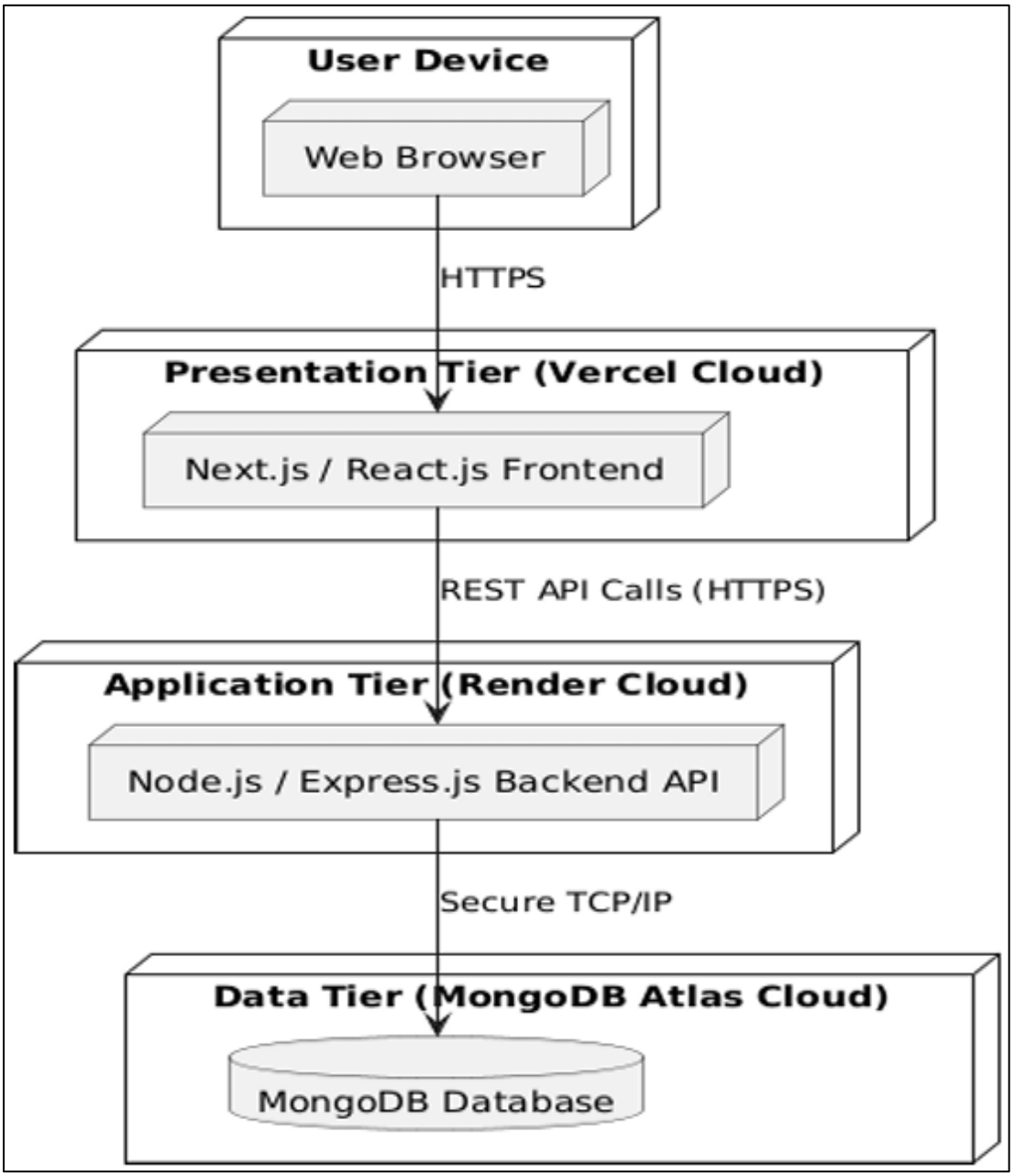

Fig 1 System Architecture

- *Use-Case Diagram*

The Digital Green Market System use case diagram illustrates the key interactions between users and the system.

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Fig 2 Use-Case Diagram

- *Class Diagram*

The Class Diagram of the *Digital Green Market System* illustrates the static structure of the system by representing its main classes, their attributes, operations, and the relationships among them. It provides a comprehensive view of how data and functionality are organized within the system, serving as a blueprint for the implementation phase.

The User class represents all types of users interacting with the system, including *Farmers*, *Consumers*, and *Bulk Buyers*. Each user possesses key attributes such as name, phone Number, email, password, role, and is Verified, which collectively ensure proper identification and authentication within the system. The class also defines two primary operations: register() for new user creation and login() for secure access.

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The Product class defines the agricultural products available in the marketplace. It includes attributes such as name, description, price, stock kg, and image URL representing the essential details of each product. Every product is associated with a single farmer who owns and manages it.

The Order class models the purchasing activities within the system. It includes attributes such as total Amount, status, and order Date to capture transactional information. Each order is placed by a user (Consumer or Bulk Buyer) and consists of one or more order items. The Order Item class represents the individual items within an order, holding specific details such as quantity and price. Each order item is linked to a single product, enabling detailed tracking of products within an order.

The relationships among these classes are defined as follows: a single User can own multiple Products and place multiple Orders. Each Order contains one or more Order Items, and every Order Item refers to a specific Product. These associations collectively define the interaction and data flow between the main entities of the system, ensuring logical consistency and efficient data management.

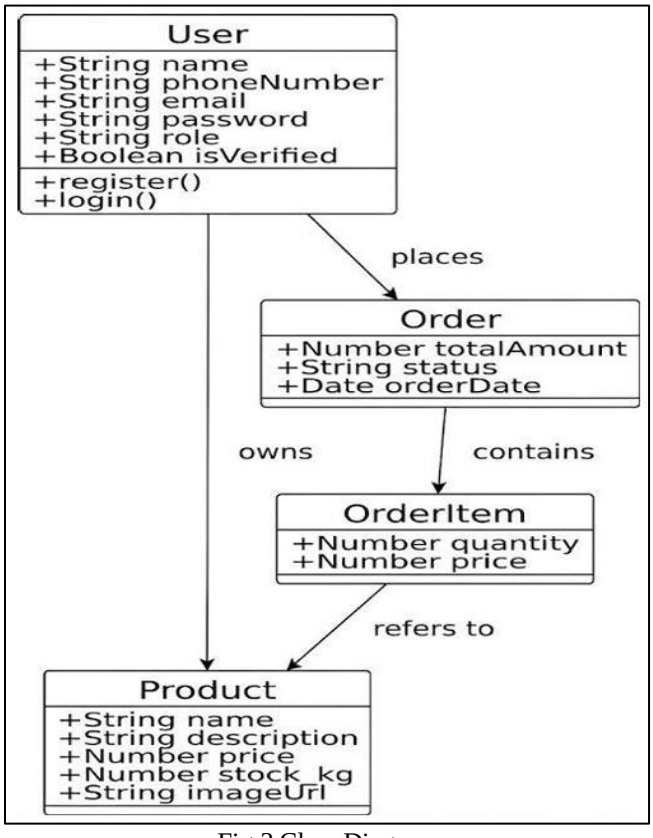

Fig 3 Class Diagram

- *Activity Diagram*

The Activity Diagram of the Digital Green Market System represents the dynamic workflow of the User Registration Process with OTP Verification. It captures the sequence of activities performed by both the user and the system, depicting the flow of control from the initial registration step to successful account creation and redirection to the login page. The process begins when the User enters their phone number into the registration interface. Upon clicking the "Send OTP" button, the frontend sends a POST request to the endpoint /api/auth/send- OTP. The backend then generates a unique One-Time Password (OTP) and either creates or updates a temporary user entry in the database. This OTP is then returned to the frontend (simulated in the development phase) to allow the user to proceed. Next, the frontend displays a pop-up message indicating OTP dispatch and transitions the interface to the Step 2 form, where the user enters their personal details along with the received OTP. When the "Create Account" button is clicked, the frontend sends another POST request to /api/auth/register, passing all user details and the OTP for verification. The backend verifies the provided OTP. If the OTP is invalid or expired, the system displays an appropriate error message and prompts the user to retry the process. If the OTP is valid, the backend finalizes the user data, creates a permanent user record in the database, and generates a JSON Web Token (JWT) for session management. Finally, upon successful registration, the frontend redirects the user to the Login Page, completing the registration workflow.

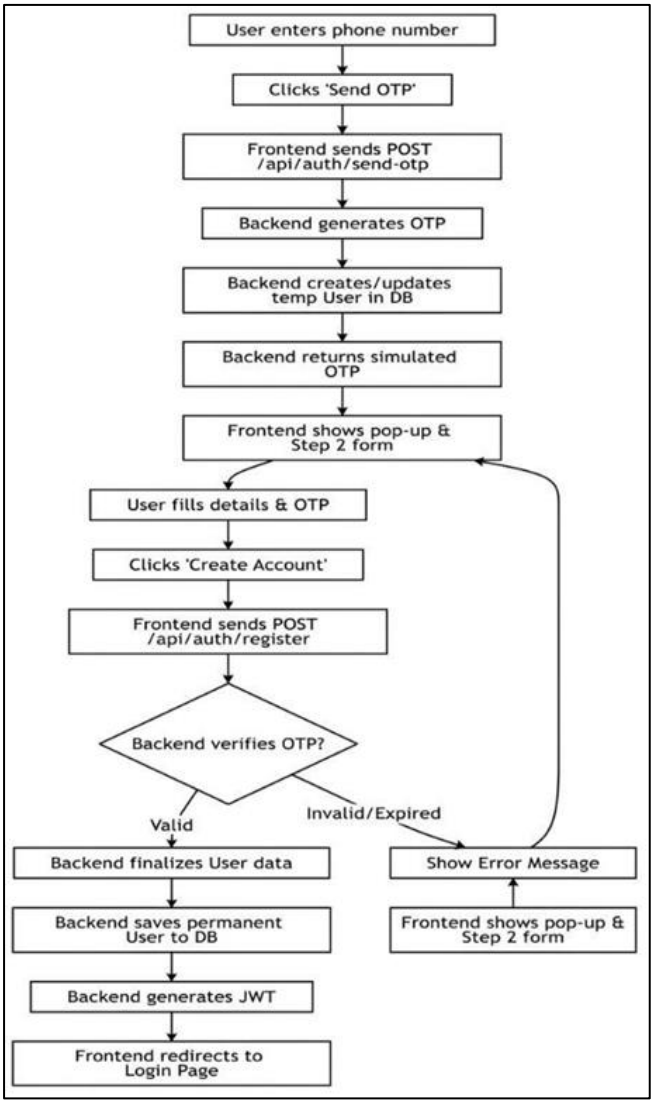

Fig 4 Activity Diagram

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- *Sequence Diagram*

This diagram illustrates the sequence of interactions that occur during the order placement process in the Digital Green Market System. It shows how a consumer's action triggers a chain of API calls that validate authentication, process order data, and store it in the database. The Consumer initiates the process by clicking the "Conform and Place Order" button on the Frontend (Checkout Page). The Frontend sends a POST request to the Backend API, including the JWT for authentication and the consumer's cart details. The Backend API passes the request to the Auth Middleware, which validates the JWT. Upon successful validation, the middleware returns a user payload to the backend for further processing. The Backend API then delegates order creation to the Order Controller. The Order Controller saves the order details in MongoDB, ensuring data persistence. Once the order is successfully stored, the controller returns a 201 Created response to the Backend API. The Backend API sends a success response to the Frontend, confirming that the order has been placed. The Frontend clears the consumer's cart, displays a success notification, and redirects the user to the Order History page.

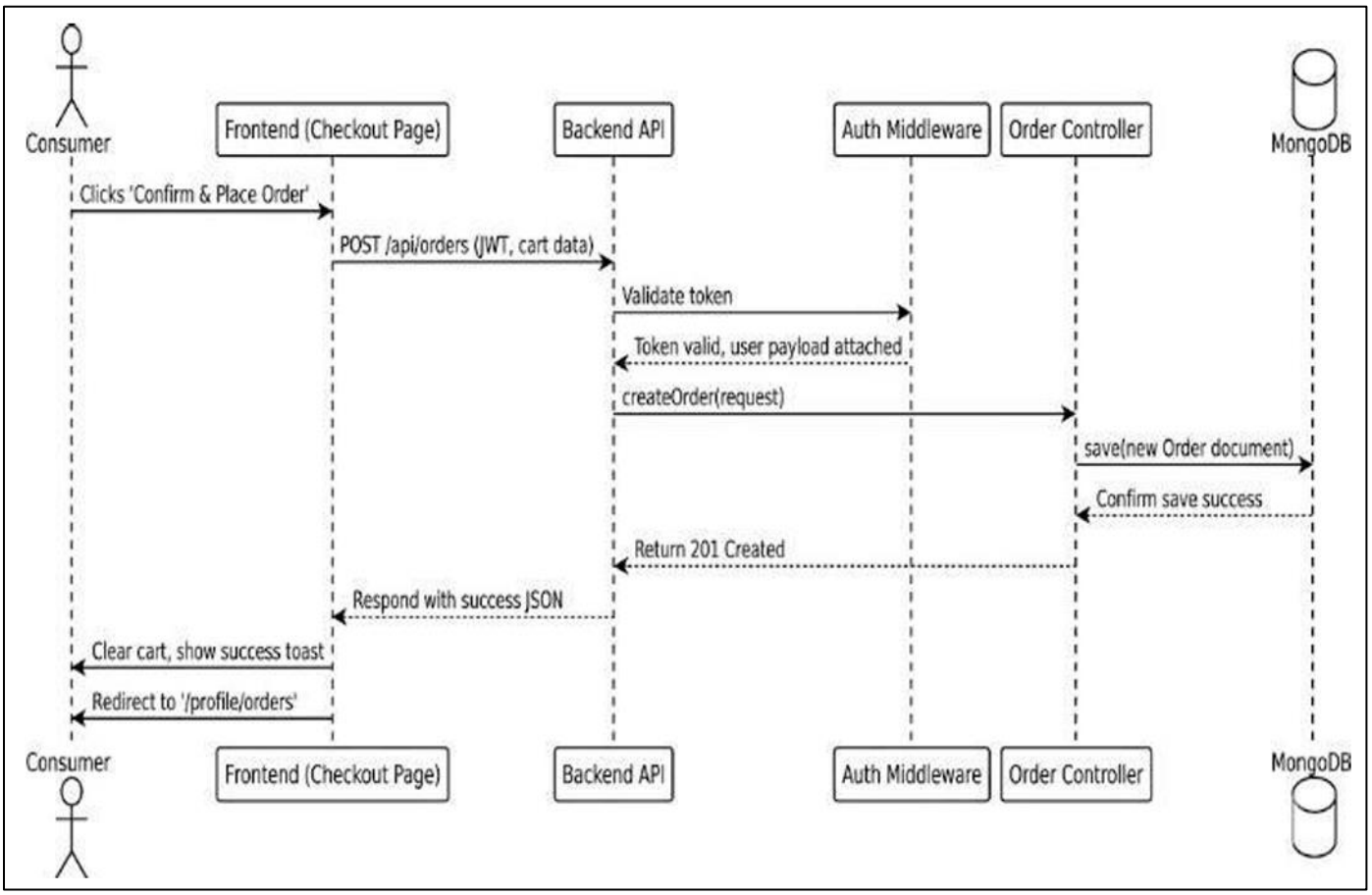

Fig 5 Sequence Diagram

- *Deployment Diagram*

The deployment diagram illustrates the runtime environment and physical distribution of components in the F2C Digital Market system across client and cloud infrastructure. The platform is deployed using a distributed cloud- based model to ensure scalability, availability, and fault isolation. End users access the system through standard web browsers on desktop or mobile devices, which act as thin clients and require no local installation. All user interactions are routed through secure HTTPS connections to protect data in transit.

The frontend application is deployed on Vercel Cloud, which hosts the Next.js build and delivers optimized static and server-rendered pages through a global content delivery network. This improves load time and ensures high availability for geographically distributed users. The backend services are deployed on Render Cloud as a Node.js and Express.js API server, where all business logic, authentication checks, and transaction processing are executed. The backend exposes secured REST endpoints and enforces token-based access control for protected operations.

Persistent data storage is handled by MongoDB Atlas Cloud, which stores user profiles, product catalogs, and order records with automated backup and replication support. The backend connects to the database using encrypted connection strings and restricted network access rules. Environment variables are used to manage secrets and configuration parameters securely across deployment environments. This distributed deployment model supports independent scaling of frontend and backend services and enables continuous updates with minimal downtime.

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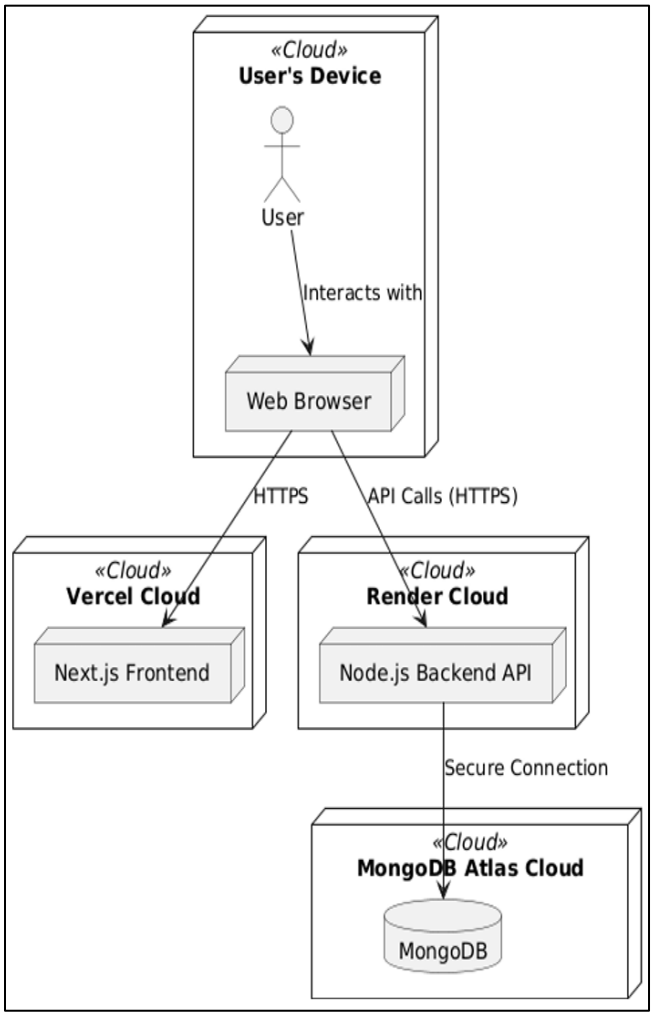

Fig 6 Deployment Diagram

V. METHODOLOGY AND IMPLEMENTATION

The F2C Digital Market platform was developed using a structured full-stack methodology focused on modular design, role-based access, and scalable web architecture. The development process began with requirement analysis, where user roles, functional modules, and data entities were clearly defined based on Farmer, Consumer, Bulk Buyer, and Admin interactions. A three-tier architecture model was selected to separate the presentation, application, and data layers for better maintainability and scalability.

The database schema was designed first, defining collections for Users, Products, Orders, and Order Items, along with validation rules to ensure data integrity. Following this, RESTful APIs were implemented using Node.js and Express.js to handle authentication, product management, cart operations, and order workflows. Each API endpoint was mapped to controller logic and protected using middleware where required. JWT-based session handling was implemented to maintain secure user sessions across requests.

On the frontend, the user interface was developed using Next.js and React.js with a component- based approach to ensure reusability and consistency. Separate dashboards were created for each user role, enabling customized features and controlled access. Responsive design techniques were applied so the platform works effectively on both desktop and mobile devices. Multilingual interface support was integrated to improve accessibility for diverse users.

OTP-based authentication was implemented for secure registration and login, reducing dependency on complex password systems for farmers. Geolocation-based filtering logic was added to enable consumers to discover nearby farm products, promoting local trade and freshness. Tier-based visibility rules were implemented so that wholesale products are accessible only to verified bulk buyers.

The system was tested using unit and functional testing methods for APIs and user workflows. Deployment was performed using cloud hosting services, with the frontend and backend deployed separately to support scalability. Overall, the implementation follows a secure, modular, and scalable methodology suitable for real-time Farmer-to-Consumer digital commerce.

To further improve reliability and usability, additional safeguards and optimization strategies were incorporated into the platform. Input validation and error-handling mechanisms were implemented at both frontend and backend levels to prevent invalid data submission and ensure stable API behaviour. Logging and structured response formats were used in API design to simplify debugging and monitoring. Role-based route protection was enforced consistently so that sensitive operations such as product modification and order status updates are accessible only to authorized users.

Performance considerations were addressed by minimizing redundant API calls and applying efficient query patterns in database access. Pagination and filtered queries were used in product listing endpoints to support large datasets without degrading response time. The user experience flow was refined through iterative UI testing, ensuring that key operations such as registration, product upload, and checkout require minimal steps.

Integration testing was carried out across modules to verify end-to-end workflows from farmer product creation to consumer order placement and tracking. The deployment architecture separates frontend and backend services, enabling independent scaling and easier maintenance updates. Configuration variables and secret keys were managed through environment settings to enhance security. This extended implementation approach ensures that the F2C Digital Market platform is robust, maintainable, and ready for real-world usage scenarios.

VI. RESULT

The F2C Digital Market platform was successfully implemented and tested as a functional full-stack web application supporting multiple user roles. All core modules including farmer registration, product listing, geolocation-

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based discovery, cart management, and order placement operated as expected under test conditions. The OTP-based authentication mechanism worked reliably for secure user onboarding and login. Role-based dashboards correctly restricted and enabled features for Farmers, Consumers, Bulk Buyers, and Admin users.

API testing confirmed stable request–response behaviour across authentication, product, and order endpoints with acceptable response times. Database operations such as product creation, updates, and order storage were validated with consistent data integrity. Geolocation filtering produced relevant nearby product listings, improving local discovery accuracy. Tier-based visibility rules correctly limited wholesale product access to verified bulk buyers only.

User workflow testing showed smooth end-to- end operation from product upload by farmers to order tracking by consumers. The responsive interface performed well across device sizes, confirming mobile compatibility.

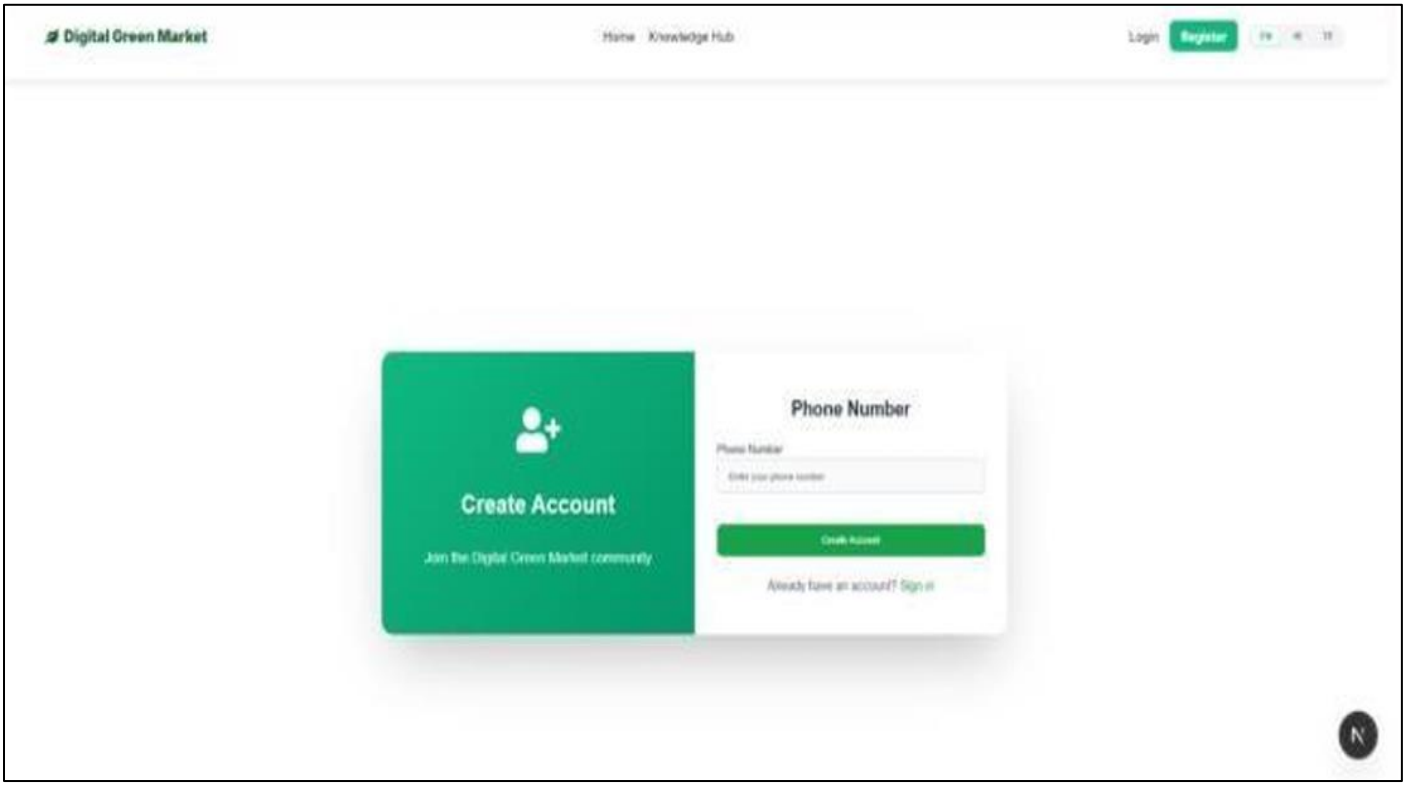

Fig 7 Register Page

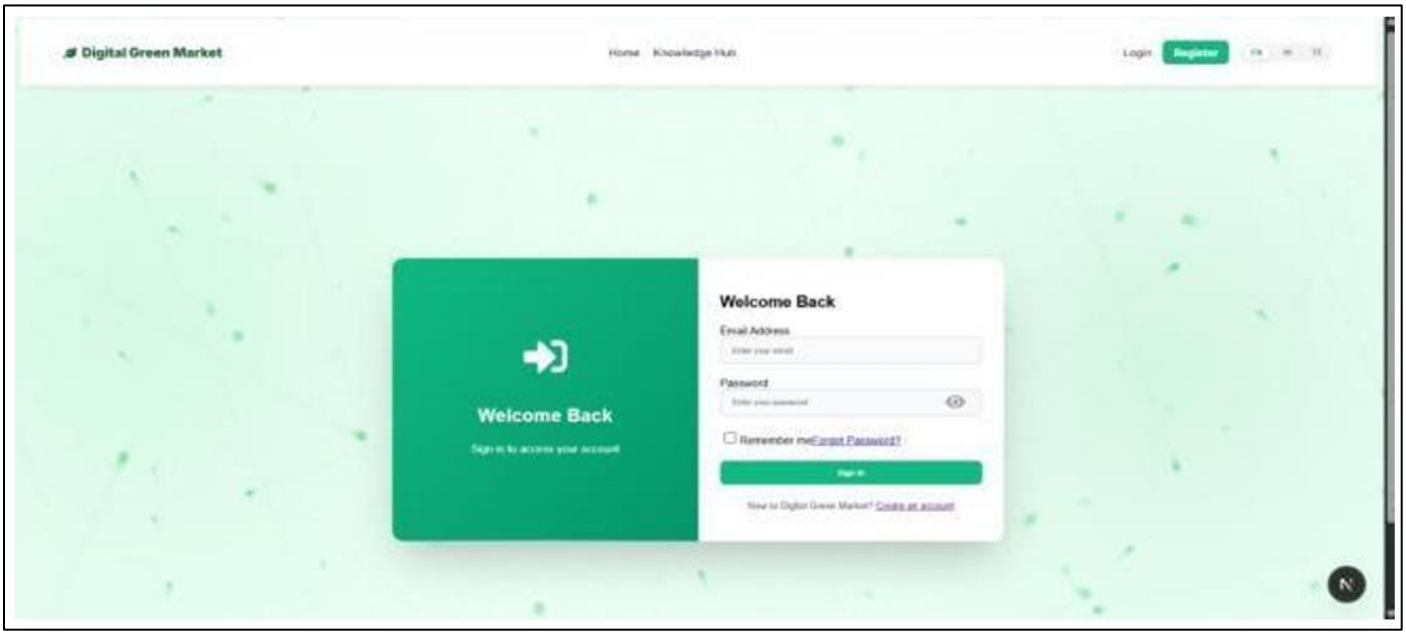

Fig 8 Login Page

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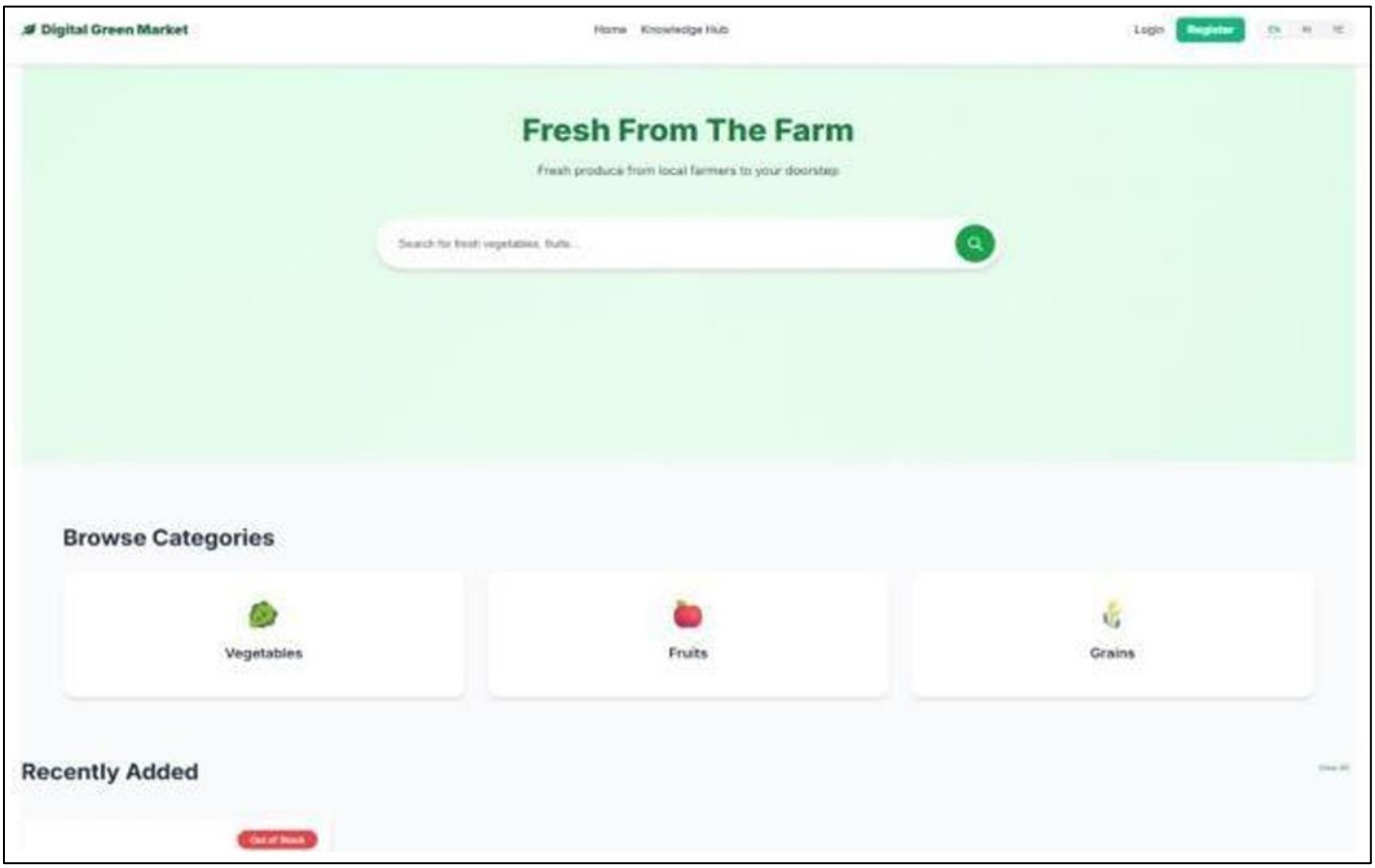

Fig 9 Home Page

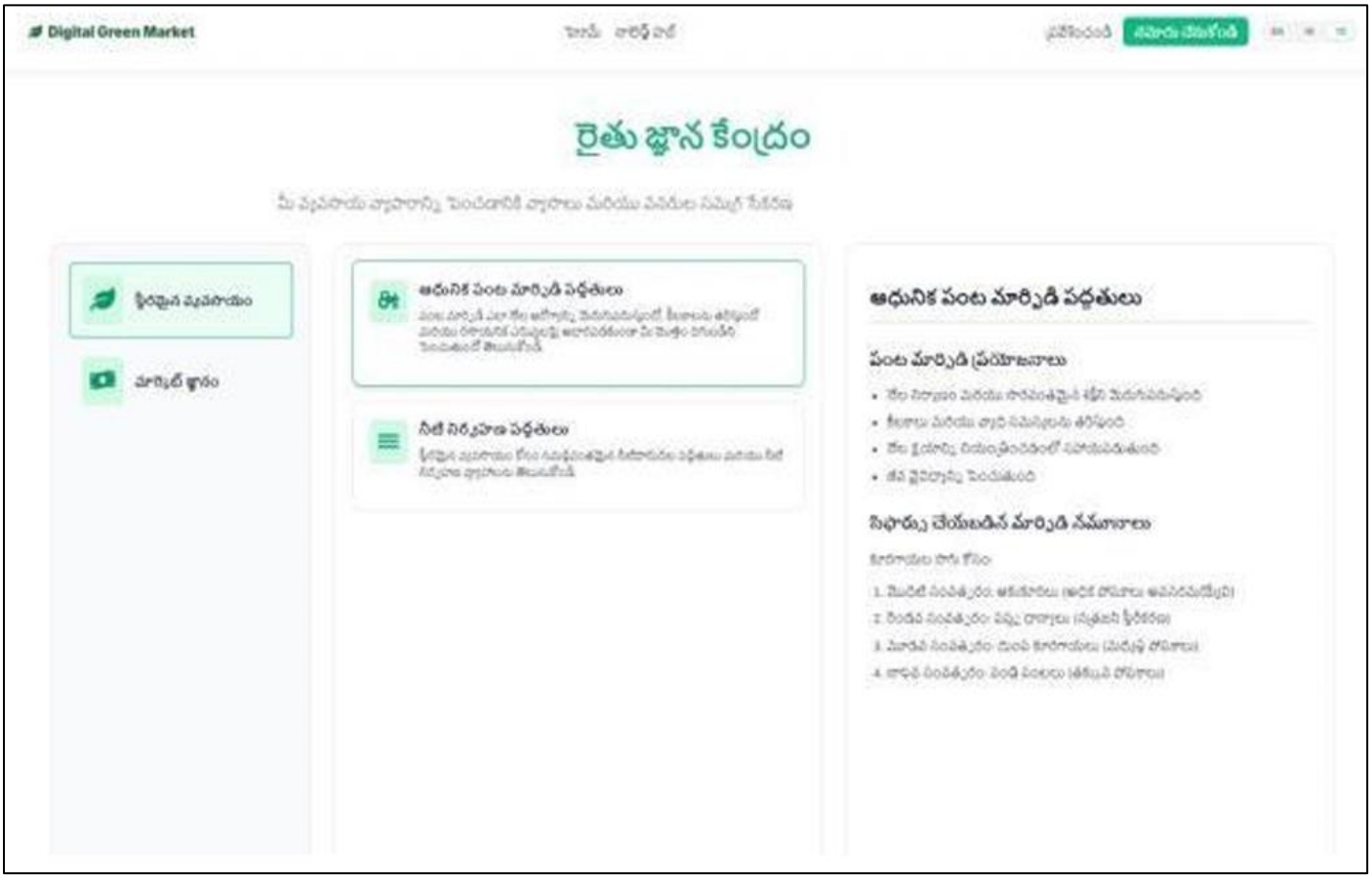

Fig 10 Knowledge Hub

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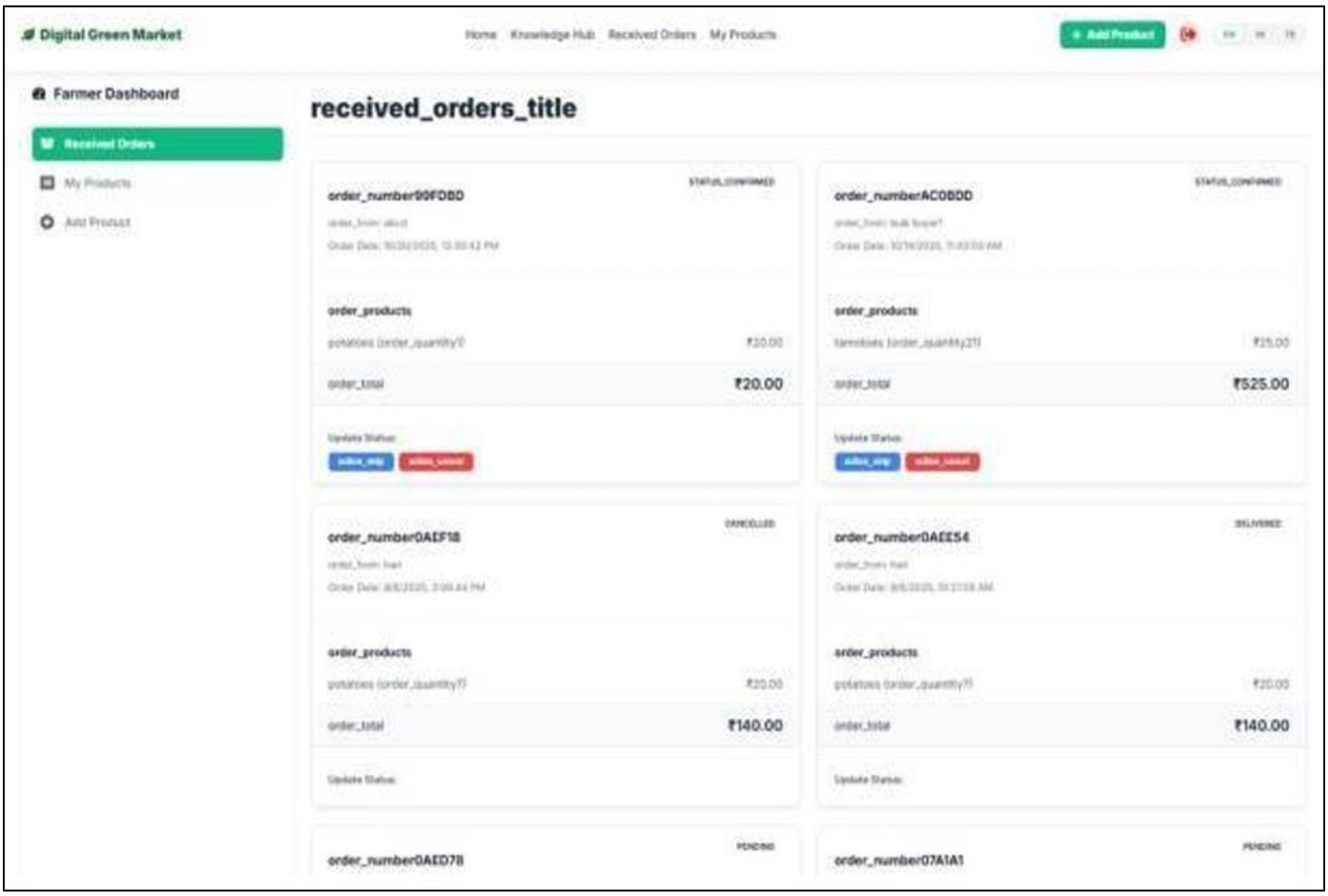

Fig 11 Received Orders

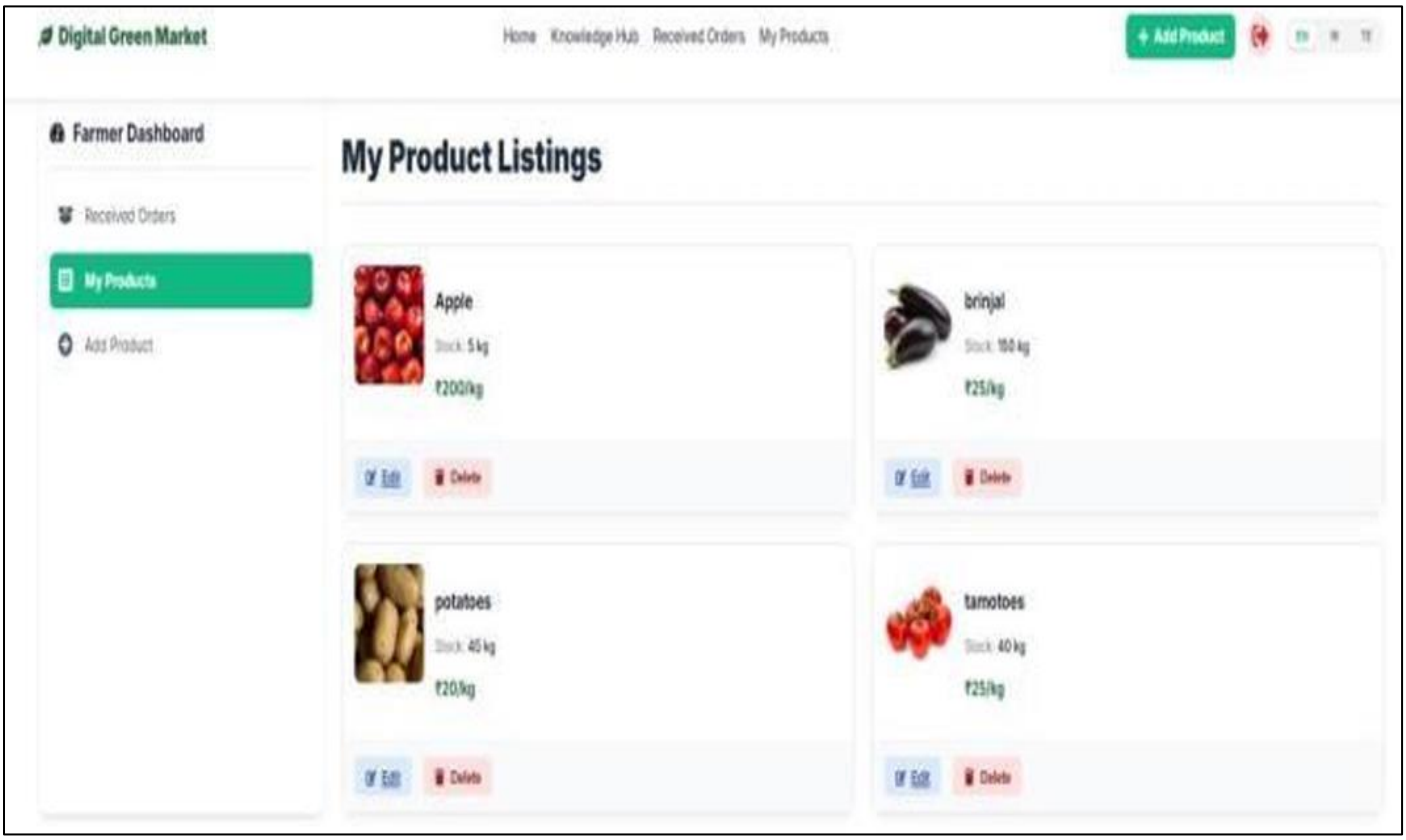

Fig 12 My Products Page

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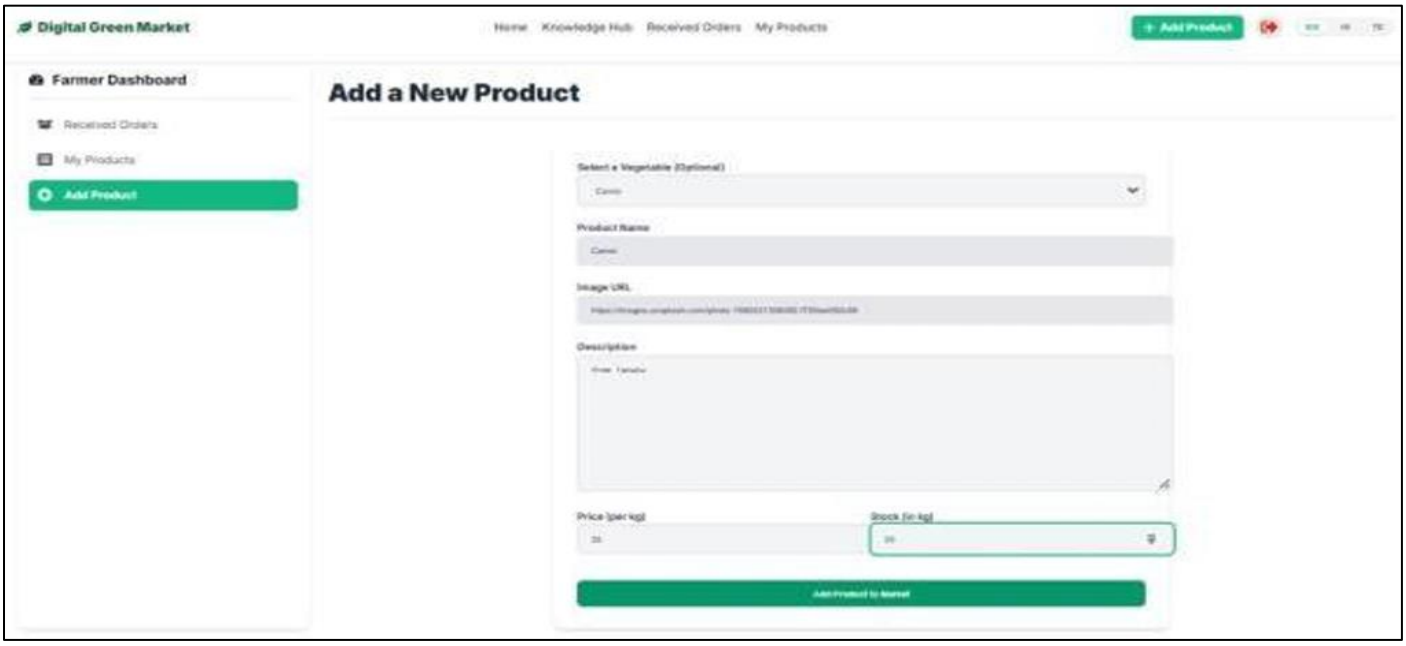

Fig 13 Add Product Page

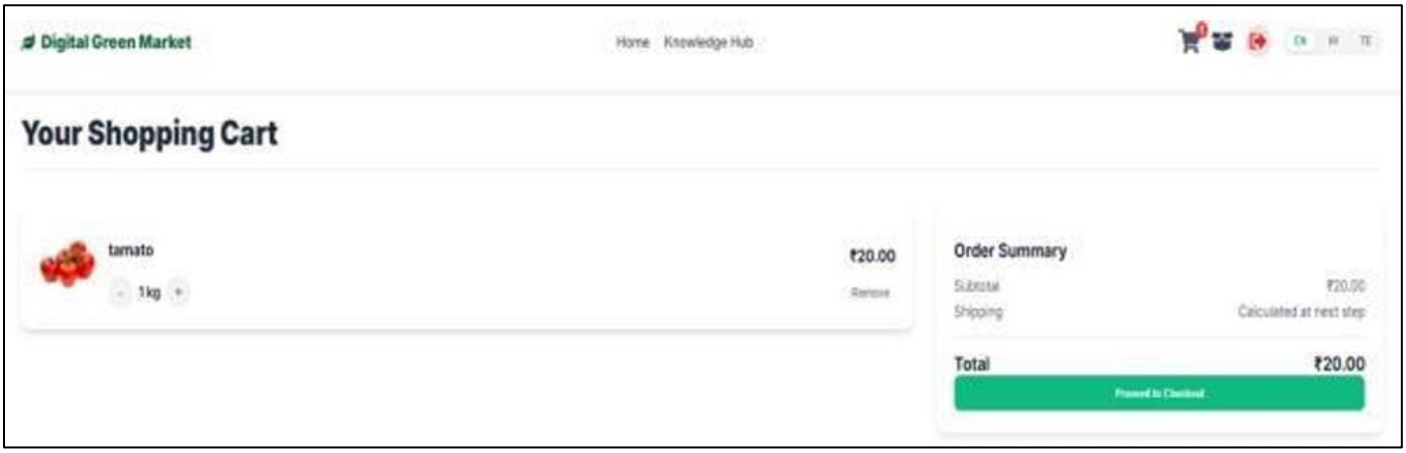

Fig 14 Shopping Cart

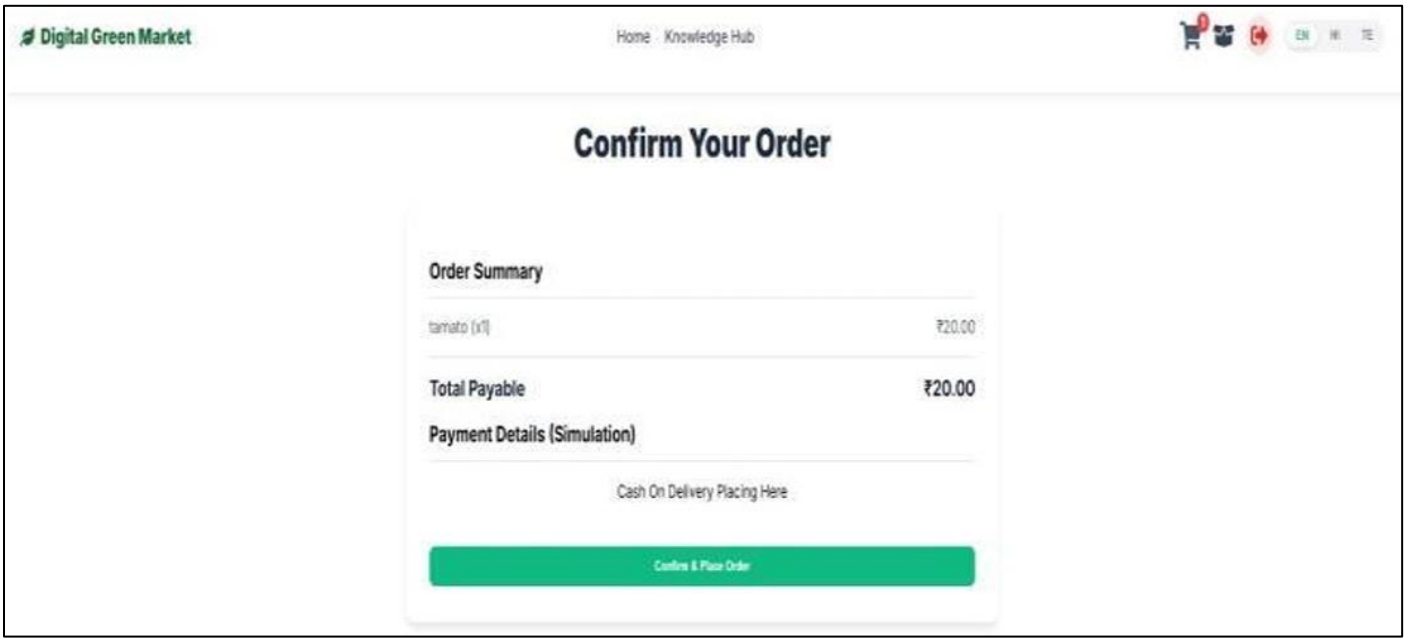

Fig 15 Order Checkout Page

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VII. CONCLUSION AND FUTURE WORK

The F2C Digital Market platform was developed to address major inefficiencies in the traditional agricultural supply chain by enabling direct digital interaction between farmers and consumers. The system successfully demonstrates how a full-stack, role-based web marketplace can reduce dependency on intermediaries and improve pricing transparency. By providing dedicated dashboards for farmers, consumers, and bulk buyers, the platform ensures structured and secure participation for all stakeholders. Features such as geolocation-based discovery, OTP authentication, tier-based product visibility, and order tracking enhance usability and trust. The modular three-tier architecture improves maintainability and supports future scalability. Testing results confirm that the platform performs reliably across core workflows including registration, product listing, and order processing. Overall, the proposed F2C system proves to be a practical and scalable solution for digital agricultural commerce.

Future work can extend the platform with real payment gateway integration and secure online transaction processing. Logistics and delivery tracking modules can be added to support end-to- end order fulfillment. AI-based demand forecasting and price recommendation features can help farmers make better selling decisions. Mobile app versions and voice-assisted interfaces can further improve accessibility for rural users. Blockchain-based traceability can be introduced to enhance product authenticity and supply chain transparency. Integration with government agricultural data services and weather APIs can also strengthen decision support. These enhancements will further evolve the F2C Digital Market into a comprehensive smart agriculture commerce ecosystem.

REFERENCES

[1]. M. K. Sharma, and P. K. Singh. (2022). "An Empirical Study on Farmer-to- Consumer (F2C) E-commerce Models in India and Their Impact on Farmer Income." International Journal of Agricultural Science and Research (IJASR), vol. 12, no. 1, pp. 45-56.

[2]. S. Goyal, and V. Kumar. (2021). "Disintermediation in the Agricultural Supply Chain: A Case Study of Digital Platforms in India." Journal of Agribusiness in Developing and Emerging Economies, vol. 11, no. 2, pp. 182-198.

[3]. Machapathri, P., Meera, S. N., & Awasthi, H. K. (2024). "Perception of Farmers About e- NAM and Digital Marketing Applications." Indian Journal of Extension Education.

[4]. N. Gupta, and R. C. Agrawal. (2020). "Challenges and Opportunities for Agri- Tech Startups in the Farmer-to-Consumer (F2C) Space." Proceedings of the International Conference on E- Business and E-Government.

[5]. G. Kanagavalli, U. Arumugam, et al. (2024). "Exploring the Growth of E- commerce in the Agricultural Products Sector: A Case Study of India." Journal of Emerging Technologies and Innovative Research.

[6]. Trivedi, and S. Singh. (2023). "Role of Geospatial Technology in Optimizing Agri-Food Supply Chains: A Review." Geomatics, Natural Hazards and Risk, vol. 14, no. 1.

[7]. S. Chahal, and A. Kumar. (2022). "Building Trust in E-Commerce for Agricultural Products: The Role of Multi- Role Platforms and Verification Systems." Information & Management.

[8]. D. Rao. (2023). "The Impact of Mobile-Based Authentication (OTP) on Technology Adoption in Rural India." International Journal of Information Management.