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FARMDIRECT: A DIGITAL MARKETPLACE FOR DIRECT FARMER-TO-CONSUMER TRADE AND VERIFIED AGRICULTURAL PRODUCTS

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ABSTRACT

Direct digital sales can provide farmers with an additional route to market, but online transactions depend on credible seller information, practical delivery arrangements, and usable pricing support. This paper describes the design and implementation of FarmDirect, a web-based marketplace for agricultural products that integrates these functions within a role-based application. Farmers can register, submit certificates, list produce, manage stock and orders, and communicate with customers. Consumers can browse listings, inspect the verification status of a seller, place orders, and follow delivery updates. A central element is a certificate-review workflow that checks for reused certificate identifiers, compares submitted records with farmer-profile details, and allows an administrator to examine supporting evidence, including official QR-linked information where available. The interface distinguishes approved and pending reviews through visible badges. The application also includes reference-price analysis, map-assisted farmer discovery, UPI-oriented payment support, messaging, and a delivery-partner dashboard. The implementation uses React, Node.js, Express, SQLite, Socket.IO, and Leaflet/OpenStreetMap. The present assessment documents the implemented functions and their design implications; controlled user trials and quantitative measurements of price accuracy, verification performance, or economic impact have not yet been reported. FarmDirect therefore provides an integrated prototype and a basis for future field evaluation of trust-aware farmer-to-consumer commerce.

INDEX TERMS: Agricultural e-commerce; farmer-to-consumer marketplace; certificate

verification; digital trust; reference-price analysis; delivery management.

I. INTRODUCTION

Selling produce directly to households is appealing to farmers because it can broaden access to buyers and provide greater visibility over the sale price. In practice, the transaction involves more than displaying a crop and accepting an order. A buyer must be able to identify the seller, judge the information attached to a product, arrange payment, and receive the goods. Farmers, meanwhile, need a manageable way to maintain stock information and respond to changing demand. These practical requirements have shaped recent agricultural e-commerce systems [1], [2], [5], [6].

Digital marketplaces can bring listings, search, communication, and ordering into a common interface. However, the presence of a seller on a platform does not, by itself, establish the legitimacy of an agricultural certificate or the correspondence between the document and the registered farmer. Consumer ratings are useful after transactions have occurred, but do not replace a review of submitted credentials. Likewise, traceability-oriented approaches based on blockchain address record integrity while introducing distinct deployment and governance considerations [7].

FarmDirect was developed around this distinction between facilitating a sale and establishing a reviewable seller identity. It combines standard marketplace functions with a certificate-checking process: identifying an existing certificate record, comparing available certificate and profile details, and routing the submission to an administrator for verification. When an official QR-linked record is available, it can support the administrator's decision. The resulting status is displayed to consumers. The system is intended to make the review state visible; a badge is not a guarantee of crop quality, organic status, or the absence of fraud.

The work makes three contributions. First, it describes a certificate-centred verification workflow that can be integrated into a conventional database-backed marketplace without requiring a blockchain. Second, it documents how the verification workflow relates to pricing guidance, location-based discovery, communication, purchasing, and delivery management across four user roles. Third, it provides an implementation-oriented account of the architecture and a candid assessment of the present evidence and limitations. The paper reports a working application rather than a controlled comparison with competing platforms.

II. RELATED WORK

A. *Direct-sales marketplaces*

CropCart, presented by Kamble et al. [1], combines product listings with purchasing, payment, location, delivery tracking, reviews, multilingual interaction, and price suggestions. Uzhavar-Nanban [2] similarly gives farmers and buyers separate web interfaces, including ordering, payment, and feedback. Sai Kishan et al. [5] describe a mobile approach with pricing information, communication, and location-aware services. Bansal et al. [6] consider direct buyer–farmer communication and the accessibility of digital trading services. Together, these studies establish the value of a unified buying-and-selling workflow, although their emphasis is not the same certificate-specific checking sequence used in FarmDirect. Other proposals, including AgroGo, AgroConnect, Farm2Home, FarmKart, and a direct farmer-to-consumer platform for Indian agriculture, further illustrate the range of digital-commerce designs explored in this area [10]–[14]. Across these efforts, marketplace functions differ in scope and emphasis. FarmDirect concentrates on how certificate review can become part of the seller registration and purchasing experience, rather than treating trust as a separate function available only to administrators.

B. Adoption, Integration, and Trust

The marketing-oriented study listed by Laksamana and Nasution [3] stresses that the availability of digital tools must be accompanied by farmer awareness and the ability to use them. Manogna [9] likewise examines factors affecting smaller farmers' access to agricultural markets, including knowledge, perceived risk, and familiarity with digital applications. These observations matter because additional checks must not make registration unnecessarily difficult. Broader discussions of agricultural e-commerce also identify opportunities and practical constraints associated with moving agricultural trade online [15].

Alsayaydeh et al. [4] connect an online market with a fertigation-oriented system, illustrating how commerce can sit alongside farm operations. Tech-Farm [8] brings together marketing, guidance, logistics, analytics, identification processes, and pricing functions. In a different direction, Takale et al. [7] investigate blockchain-based supply-chain transparency. The design choice in FarmDirect is narrower: it maintains certificate records in the application database and relies on administrator review to resolve suspicious or incomplete information. This design avoids a decentralized ledger, although it also creates an operational dependency on administrators and on the reliability of external certificate sources.

The gap addressed in this study is therefore not the absence of online agricultural markets. It

is the need to describe and integrate a concrete farmer-certificate review process with the day-to-day operations of a direct-sales marketplace, while keeping the distinction between a submitted document, a pending review, and a verified account clear to consumers.

III. SYSTEM DESIGN AND ARCHITECTURE

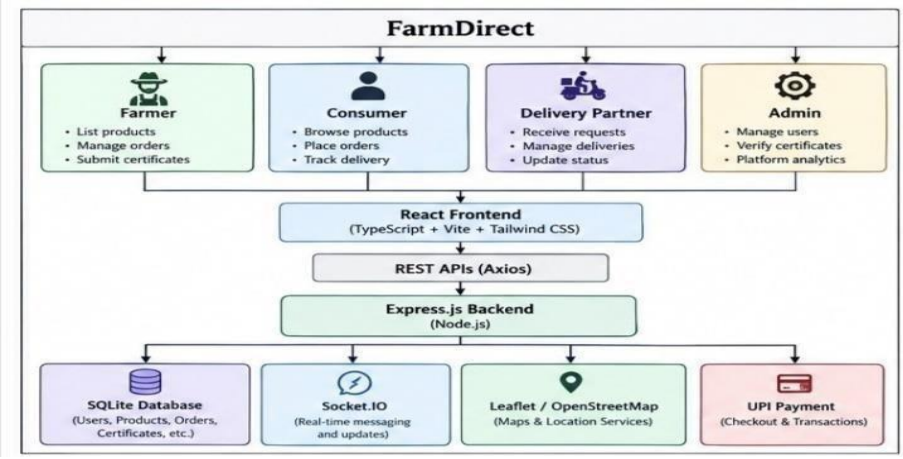


Fig. 1. Overall FarmDirect Architecture and the Four Participating User Roles.

A. Participants and responsibilities

FarmDirect provides separate interfaces for farmers, consumers, delivery partners, and administrators. Farmers create profiles, upload certificates, list produce, change available quantities, and handle orders. Consumers discover products, inspect seller information, communicate with farmers, place orders, and submit feedback. Delivery partners receive assignments, view pickup and drop-off details, update the delivery state, and maintain a delivery history. Administrators manage accounts and product records, review certificates, handle complaints, and examine marketplace information. Restricting these activities by role keeps the interface focused and supports different authorization requirements.

TABLE I: ROLES AND PRINCIPAL OPERATIONS IN FARMDIRECT.

Role	Principal operations
Farmer	Profile and certificate submission; product and inventory management; order handling; price guidance.
Consumer	Product and farmer discovery; verification-status viewing; cart, orders, messaging, reviews.
Delivery partner	Assignment tracking; pickup/drop-off navigation; status updates; optional parcel photographs.
Administrator	Account and certificate review; product/order oversight; complaints and reports.

B. Application architecture

The platform follows a three-layer web architecture. A React and TypeScript presentation layer communicates with an application layer implemented using Node.js and Express through REST APIs. The application layer provides authentication, role-aware access, product handling, orders, messages, certificate records, and delivery services. Persistent records—including users, product listings, orders, certificate information, complaints, and messages—are maintained in SQLite. Socket.IO supports live messaging and updates. Leaflet and OpenStreetMap supply the maps used for farmer discovery and delivery navigation; saved addresses may be geocoded when coordinates are unavailable. UPI-related payment functionality is part of the checkout flow.

Figure 1 shows how role-specific activities reach the shared backend services. Figure 2 expands this view by separating the web interface, REST layer, persistent data store, real-time channel, and mapping services. The diagrams document system organization, not latency, scalability, or fault tolerance.

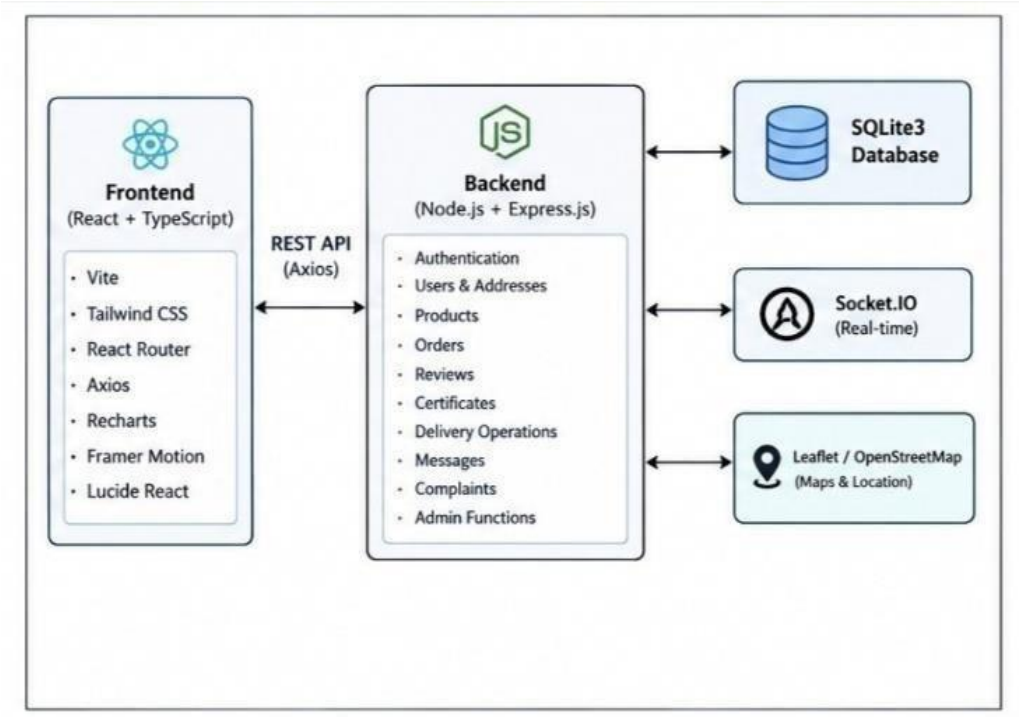


Fig. 2. Technical components and communication paths used by the application.

C. *End-to-end transaction flow*

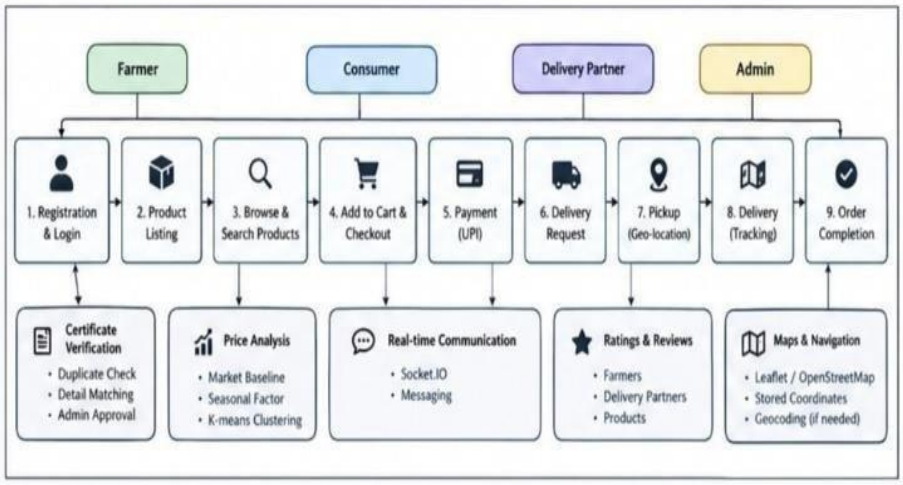


Fig. 3. Farmer-to-consumer workflow, with supporting verification, pricing, messaging, review, and location services.

A farmer begins by registering and, when relevant, submitting a supporting agricultural certificate. After completing product details, the farmer can publish an available quantity and selling price. A customer searches or browses listings, checks the seller's current verification state, and may ask questions before ordering. The platform records the purchase and supports UPI-oriented payment. A delivery request can then be managed through a delivery-partner interface. Order updates, messaging, and buyer feedback continue the interaction after checkout. Figure 3 summarizes this process and its supporting modules.

IV. CERTIFICATE VERIFICATION AND PRICE-ANALYSIS METHOD

A. Certificate review sequence

A certificate submission is linked to the corresponding farmer account. The first check searches stored certificate identifiers to detect possible reuse across accounts. The second compares available fields in the certificate with farmer-profile details. A mismatch does not establish fraud; it marks the record for manual investigation. The administrator reviews the document and registration data and, where the certificate provides a valid QR-linked government record, may consult that source before deciding whether to approve it. This final review is deliberately human-mediated rather than described as automatic government validation.

The interface uses a green badge when the administrator has approved the submission and a yellow badge while review is pending. Duplicated or inconsistent submissions require attention rather than automatic promotion to the approved state. In the current

implementation, the public-facing badge communicates only whether the review is approved or remains pending. The distinction is important: the badge describes the platform's account-review outcome, not independent certification of each product listed by that account.

TABLE II: CERTIFICATE REVIEW CHECKS AND INTERPRETATION.

Stage	Information considered and interpretation / action
Reuse screening	Submitted identifier against existing records — Possible reuse is flagged for review.
Profile comparison	Certificate fields and registered farmer details — Discrepancies are referred to an administrator.
External review	Document or QR-linked official information, if available — Administrator checks supporting evidence.
Status display	Outcome of the administrator review — Green: approved; yellow: pending. No additional state is assumed.

B. *Reference-price analysis*

FarmDirect includes a price-guidance module to help a farmer consider an asking price before publishing a listing. The implemented method uses predefined reference values for common crops, seasonal adjustments, bounded longer-term changes, and the use of stored market or application prices when no predefined baseline is available. It also describes k-means clustering applied to ten years of monthly price observations to identify groupings in the historical data. The resulting suggestion is advisory: the farmer retains control over the final selling price.

The current price module has not yet been benchmarked against independently observed market prices. A reproducible comparison would require documentation of the historical dataset origin and geographic coverage, the number of clusters, input scaling, the combination of clustering with baseline rules, and suitable error metrics; these details are outside the present functional assessment. Accordingly, no numerical accuracy, revenue benefit, or forecasting advantage is claimed. They will be necessary in a reproducible evaluation of the price module.

C. Discovery, messaging, and fulfilment

Location-based search helps buyers locate farmers using available coordinates or geocoded addresses. Real-time communication is handled through Socket.IO, allowing users to clarify product availability and delivery arrangements. The checkout process includes UPI-oriented payment support and records order information in the application. For fulfilment, the assigned delivery partner can view the pickup and destination locations, update progress, and

optionally record photographic evidence. Ratings and reviews provide post-transaction feedback, complementing—but not substituting for—the certificate-review process.

V. IMPLEMENTATION

The reported frontend stack consists of React 19, TypeScript 6, Vite, Tailwind CSS 4, React Router, and Axios. Backend services are implemented in Node.js with Express.js 5, and REST endpoints expose the application operations. SQLite3 persists records. Socket.IO supports messaging and update events, while Leaflet/OpenStreetMap provide the map layer. Role-based access controls separate the farmer, consumer, delivery-partner, and administrator experiences. The implementation description focuses on the software components and their interactions; production deployment, security hardening, and stress testing remain outside its reported scope.

From an engineering standpoint, the verification module is placed within the same account and data-management environment as the marketplace. This gives the administrator access to information needed to connect a seller's record with submitted credentials and makes the resulting review status available at the point where a buyer inspects a listing. The implementation remains dependent on the quality of the uploaded document, the consistency of registered data, and administrator judgement. Supporting official-site checks are contingent on the relevant certificate and government service providing a usable verification mechanism.

VI. FUNCTIONAL RESULTS AND DISCUSSION

A. *Scope of the reported assessment*

FarmDirect has been implemented as a full-stack application with role-specific interfaces and connected marketplace functions. It does not provide a controlled study, a documented test cohort, a benchmark dataset description, response-time statistics, a security audit, or before-and-after economic measurements. The observations below should therefore be read as a functional account of the implementation, not as experimentally demonstrated improvement in farmer income, verification accuracy, buyer trust, or system throughput.

B. *Marketplace and verification observations*

The application brings seller profiles, crop information, product availability, orders, communication, and delivery updates into connected workflows. Product records include names, quantities, prices, harvest information, descriptions, and images; farmers can revise quantities as availability changes. Buyers can browse those records and proceed through the

cart and order flow. This consolidation reduces the number of separate interfaces required by the proposed design, although user-effort savings have not been measured.

The principal distinguishing feature is the relationship between a farmer's account and a reviewable certificate record. Reuse screening and profile-field comparison help identify submissions that need attention. The administrator then decides whether the available evidence justifies approval, and the interface communicates the result with a visible badge. The design introduces a checkpoint that is absent from a listing-only workflow. It does not remove the risk of forged documents, inaccurate external information, mistaken human decisions, or misleading claims about particular produce.

C. Price analysis, mapping, and delivery

Farmers receive a reference-price suggestion derived from the reported market rules and historical-price clustering. This can provide a starting point for considering a listing price, but the paper cannot yet assess the advice against realized market transactions. Likewise, map-based discovery and address/coordinate handling supply routes into seller discovery and order fulfilment; travel-time savings and delivery efficiency have not yet been measured under field conditions.

The delivery-partner dashboard records assignments and changing delivery status and supports location-based pickup and drop-off. Optional pickup or delivery photographs add a record of handover events. Messaging, UPI-oriented checkout, and customer feedback complete the transaction experience. Each function addresses an operational step, but its effectiveness still needs to be assessed with representative users and real transaction conditions.

D. Design implications and limitations

The implementation illustrates a practical alternative to making every trust-related activity dependent on a distributed ledger. A conventional database, visible review states, and administrative checks may be easier to integrate with a small web application. Nevertheless, this approach is not inherently more secure than blockchain-based systems, nor can the available evidence establish lower cost or better scalability. The two architectures make different trade-offs: FarmDirect centralizes review and accountability, whereas a decentralized design may emphasize distributed record integrity [7].

Several questions remain open. Certificate review may become a bottleneck if registrations increase; administrators need clear decision criteria, review logs, and a process for appeals.

The system should also make a clear distinction between account approval and certification of a specific crop lot. On the engineering side, an appropriate production assessment should examine authentication, upload security, payment reconciliation, data privacy, database growth, backup procedures, and service availability. Usability tests with farmers who have different language preferences and levels of digital experience would help determine whether the additional verification steps are practical [3], [9].

VII. CONCLUSION AND FUTURE WORK

FarmDirect brings together the core functions of a direct agricultural marketplace with a certificate-review process that is visible to buyers. The developed application includes role-based interfaces, product and inventory management, ordering, reference-price guidance, messaging, map-assisted discovery, UPI-oriented checkout, and delivery coordination. Its central design contribution is to connect duplicate-record checks and farmer-detail matching with administrator review and an explicit approved-versus-pending indicator. The paper documents how these components fit into a full-stack web application; it does not establish quantitative gains in income, trust, price accuracy, or delivery performance.

The next stage should be a structured evaluation. For verification, that would include a documented set of genuine, duplicated, inconsistent, and invalid certificate cases, along with review time, error rates, and administrator agreement. For pricing, the historical data source, preprocessing, clustering settings, and recommendation formula should be reported and compared with appropriate baselines. Field studies should measure task completion, usability, purchasing outcomes, and delivery experience. Further development may involve optical character recognition, authorized integration with official verification services, additional Indian-language support, route planning, traceability for individual batches, stronger operational security, and scalable deployment. These changes should be assessed before claims of real-world effectiveness are made.

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