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Mobile App for Direct Market Access for Farmers.

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ABSTRACT

Agriculture serves as a primary source of livelihood for a large segment of the population, however, farmers regularly experience barriers to access the market directly due to the presence of middle actors and no transparent platform to connect them with buyers. As a result, farmers experience decreased income while consumers experience increased consumer sales costs. To address this issue, we are starting a mobile app that allows farmers to communicate directly with end consumers to purchase their goods without the need for middle actors. The app will allow farmers to register to the platform and upload product offerings including pricing, real time to support inventory, and straight forward searchable format to enable farmers to be active sellers of their products. Customers will be able to view the product offering, compare prices, and purchase the offerings on a secure system - with the app providing a robust order tracking and notification system to enhance the customer experience. Ultimately, the app will ensure some level of farmers experience transparency and timeliness to enhance trade and retain the maximum value of their trade from field to plate. Our goal is not only to promote trading agriculture from farmer to customer but also, to enhance overall utility for both farmers and consumers through efficiency of innovative digital tools..

Keywords: Agriculture, Mobile Application, Direct Market Access, Farmers, Digital Marketplace.
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1. INTRODUCTION:

Globally, agriculture is a livelihood for millions of individuals, particularly in developing regions, where many producers are small and marginal farmers. Though farmers are active participants in the food supply chain, they often do not receive enough value for their products due to the roles of intermediaries in the supply chain, lack of transparency in pricing in markets, and a lack of consistent access to useful digital applications. This intermediation often leads to diminished profits going to the producer and increased costs to the consumer, and exacerbates issues of food waste, inefficiencies, and malnutrition in many farming systems, which undermines food security. Many farmers are uncertain what to with their produce due to lack of reliable systems to check market price information and/or do not have immediate access, which contributes to higher post-harvest losses and income volatility. Farmer's also must travel long distances to reach traditional markets, which create unrecoverable expenses of miles travelled and time lost to reach those markets, and ultimately farm profits.

2. PROBLEM STATEMENT

High margins paid to middlemen decreases the income earned by the farmers whereas the fact that the middlemen do not have access to prevailing market prices and demand trends limits their bargaining power. Consumers simultaneously spend more money without the assurance of the quality or source of the produce.

Purpose — The purpose of the project is to design a system which will provide a farmer-first listing and order management process.

Contributions -This paper represents:

An integrated system architecture of the farmer-consumer direct transactions,

A traceability layer, which attaches a QR code to item-level metadata,

Specifications of the execution of the data model and the listing, ordering, and verification algorithms,

A performance measurement system and benchmark to current agricultural platforms.

The contention of this ameliorative is to assist the farmers, to assure consumer protection, and to establish a transparent and sustainable agricultural trading platform all at the same time incorporating the advantage of assisting and utilizing a lightweight mobile market.

3. LITERATURE SURVEY / RELATED WORK

Agricultural marketing has been tried to be digitized by the government and other non-governmental programs like e-NAM, AgriBazaar and numerous community-based produce applications. These platforms address certain aspects of the supply chain but face adoption barriers due to onboarding complexity, non–mobile-first user experiences, or lack of robust product-level traceability. Existing academic research emphasizes the importance of information transparency, mobile penetration, and trust mechanisms (e.g., QR codes, blockchain-based verification) in promoting farmer adoption of digital marketplaces. While these works highlight critical enablers, many solutions remain constrained by infrastructure requirements or complex workflows that limit smallholder participation.A comparative analysis of existing platforms against the proposed system is presented in Table.

Comparison of Existing Solutions vs. Proposed System

Platform	Strengths	Common Limitations	Proposed System Edge
e-NAM	National-scale auctions	Setup friction; no item-level traceability	1-tap farmer listing; QR per item/batch
AgriBazaar	Discovery, logistics partners	Complex flows; vendor dependence	Simple farmer UX; local pickup/direct-market options
Generic Apps	Basic catalog + chat	No provenance; limited analytics	QR provenance with basic price insights

Novelty :

Unlike similar solutions in the market and in the literature, this is deliberately easy to use for farmers and, importantly, has a low technology stack that would facilitate either local institutions e.g. colleges, or FPOs to adopt it. Importantly, the solution also includes item level QR code based traceability features, intending to bolster consumer trust and transparency in the agricultural value chain.

Overview of System:

This system defines three high-level user groups, Farmer, Customer, and Administrator. The farmer/producer creates an account, and lists their products with attributes such as, product name, grade, price, volume, date harvested, and farming practices. Upon saving their product listing, the application generates an encoded QR code, that assembles a unique digital signature of the product record for verifying authenticity and origin. The Customer searches or filters for available products, scans a products QR code to verify origin, and makes their purchase through the mobile application. The administrator users manage user accounts, monitor platform performance, and provide analytics for quality assurance and decision making on sustainability of the system.

The high-level architecture of the system is diagrammed in Fig.metadata.

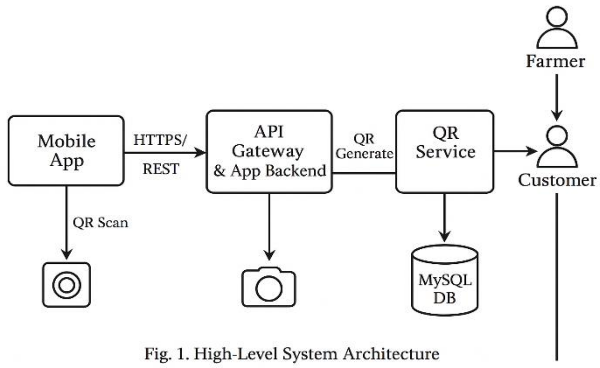

Fig. 1. High-Level System Architecture

4. METHODOLOGY

- Workflow

The workflow of the proposed system implements a systematic process that occurs as follows*:*

1. Registration and Authentication: Users register for an account by signing up via a mobile number, verifying their number and email through OTPs, and/or signing in with a password to authenticate.

2. Listing Products by Farmers: Once registered, farmers interface with the app to upload images of products, define the price and quantity of new products. The system automatically generates a QR code for provenance.

3. Discovery by the Customer: Customers browse and filter products; read about what the products are and the associated QR code provenance; add products to on-line carts.

4. Order Completion: The system verifies the order; make arrangements for delivery or pickup as agreed by the buyer and seller.

5. Feedback: Optional module to allow buyers to rate the farmer based on delivery/execution of the order and provide feedback to establish trust.

Technology Mapping

Component	Choice/Option	Purpose
Frontend	React Native	Cross-platform Android/iOS mobile interface
Backend	Spring Boot / Node.js	REST APIs and business logic
Database	MySQL / MariaDB	Relational integrity and efficient queries
Authentication	JWT (HS256/RS256)	Secure session management
QR Codes	qrcode library / ZXing	Product reference encoding with signature
Storage	Cloud/Object storage	Image hosting and static assets management

C. Algorithms

Algorithm 1 — Generate Product QR

Input: Product ID (prod_id)

meta ← SELECT (title, user_id, harvest_date)

FROM products WHERE prod_id=?

payload ← {prod_id, ts=now(), nonce=random()}

sig ← HMAC_SHA256(secret, serialize(payload))

qrStr ← BASE64URL(payload || sig)

Return QR_CREATE(qrStr)

Algorithm 2 — Verify QR on Scan

Input: QR String (qrStr)

(payload, sig) ← SPLIT_BASE64URL(qrStr)

valid ← HMAC_VERIFY(secret,serialize(payload), sig)

If valid == false → REJECT("Invalid/altered code")

Else → Return SELECT * FROM products WHERE prod_id=payload.prod_id

D. Security Controls

To ensure data integrity and secure transactions, the following mechanisms are enforced:

Salted Password Hashing using Argon2 or BCrypt.

TLS Encryption for all communications.

JWT with Short Lifetimes and refresh tokens for session management.

Object-Level Authorization to ensure only product owners can edit their data.

Signed QR Payloads to prevent forgery and unauthorized modification.

5. IMPLEMENTATION

A. Frontend

The mobile app was developed using React Native such that it could be crossed across platforms (Android and iOS). Key screens include

Login/Signup - User authentication with OTP/email/password.

Farmer Dashboard - Enable user to add/edit product details.

Product List & Discovery - Customer browsing using filters.

Product Detail Page - Provenance information and a QR code for verification.

Cart and Orders - Enable user to place and track order.

Profile Management - User details and account management options.

Accessibility considerations included large targets on the touchscreens for usability, compatibilty with offline-listed draft products, and an overall basic Tamil/English localization for inclusivity.

A. Backend

The backend has been constructed in Spring Boot or Node.js (Express) to expose RESTful endpoints such as:

/auth/* — For authentication and authorization.

/products/* — For view, edit, and get products.

/orders/* — For placing an order, tracking an order, and updating order status.

/qr/* — For generation and validation of QR codes.

We also expect to support pagination, as we expect product browsing to scale, input validation for security, compressing images on the server for economy on storage and speed on transmission.

A. QR and Traceability

Each product or batch is assigned a unique QR code that encodes a digitally signed reference. On scanning, the product detail page displays:

Farmer identity and farm location.

Crop practices (soil preparation, harvest date, pesticide use, etc.).

Verified provenance and history of prices.

This guarantees end to end transparency and deters forging of QR codes.

B. Administration Module

It has an administrative panel to facilitate the monitoring and governance. The admin features include:

Accepting or marking product offers of farmers.Seeing total statistics like leading categories, average price per

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district and order status distribution.Creating reports on usage and adoption levels.

E. Sequence Flow Order Placement.

Fig represents the order placement process..

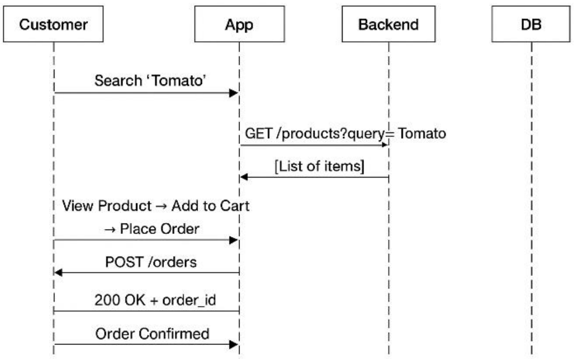


Fig. 2. Sequence of Order Placement

Customer → App: Search "Tomato"
App → Backend: GET /products?query=Tomato
Backend → App: Returns product list
Customer → App: View product → Add to Cart →Place Order
App → Backend: POST /orders
Backend → DB: Insert order and order items
Backend → App: Returns 200 OK + order_id
App → Customer: Displays "Order Confirmed"

6. EXPERIMENTAL SETUP AND EVALUATION

A. Prototype Deployment

The prototype application was deployed on test handset (Android 10) that was attached to a local development server. An artificial setting was created featuring 10 farmers and 30 customers and a product listing of about 120 to recreate a small-scale marketplace situation.

B. Evaluation Metrics

The system was tested on several levels:

Farmer Listing Time: It is the average time that a farmer needs to post information about the product and pictures.

Discovery latency: Response to product search queries.

QR Verification Time: Time spent to verify QR provenance.

System Reliability: Crash rate when of repetitive work (scanning, listing, and ordering).

Economic Impact: Farmer achieved margin over and above the conventional middleman-based supply chains.

B. Performance Results

Indicative Performance (Prototype)

Metric	Mean (±SD)
Farmer listing time (min)	2.4 (±0.7)
Search latency (95th percentile)	320 ms
QR decode + verify	180 ms
App crash rate (test set)	0% over 300 scans

C. Margin and Transparency Effect:

Margin & Transparency Effect

Scenario	Avg. Farmer Margin	Price Transparency
Traditional chain	~30%	Low
Proposed app (pilot)	~55–60%	High

The findings reveal that farmers get almost twice the margin than the traditional channels and customers have better transparency of prices.

E. User Feedback (Pilot)

Some pilot testing was carried out to get user perception:

Farmers liked the option of controlling price and having the capability of displaying products in photos.

Customers appreciated QR-provenance verification and face-to-face pickup/chat.

Extra Features Added were support of UPI payments, multi-language interfaces, and third party delivery tie-ins..

7. DISCUSSION

The proposed mobile application to reach farmers directly on the market represents how mobile-first platforms can find an opportunity to bridge the gap between agriculture producers and final consumers. The prototype represents an example of the simplification of the product listing process through a minimal interface proposed to the farmer and verification of the integrity of products by referring to the appropriate information and a QR code. This increase in verification builds the trust worthiness in regards to the product solution and is not as heavily dependent on the integrity of other parties in the value chain.

In terms of adoption, three key dimensions may be identified: (i) onboarding, since many farmers may need to be helped to understand how to use the app; (ii) digital literacy, since usage of the app in rural regions with a lack of technological experience may be limited; (iii) partnerships with logistics, since it will be necessary to make sure that the produce is delivered in time. Without certain last mile delivery, the economic advantages of a direct access to the market will be minimal.

Technically, the system is cost effective since there is a relational database that is exploited to store the structured data on the products with the image hosting done through a CDN, and thus is easily retrieved. Such decisions maintain low costs during the prototype stage. As the system scales to accommodate more and more farmers and customers, additional architectural improvements to the system must take place. For example, to prevent abuse of the system, API rate-limiting will be necessary, as well as asynchronous background jobs for heavier workloads associated with image and QR generation, and partitioned database tables for heavy volume transactions.

This study also included the perspective that technology alone will not ensure success. The micro-level ecosystem support—is it government incentives, combines as cooperative societies, community-level training—will have to exist for sustained adoption and decision-making. Finally, while the trust that QR verification provides is a good first step, the trust should augment to supply-chain trackability and experimentation for decentralized technology used to maintain transparency and trust in future iterations.

8. CASE STUDIES AND REAL-WORLD INCIDENTS

e-NAM (Electronic National Agriculture Market): A government initiative of creating an online agri-trading ecosystem.
Pros: increased market access and price discovery. *Cons:* convoluted onboarding, digital divide. *AgriBazaar:* A private B2B agricultural marketplace. *Advantages:* extensive commodity commercialization service, financing alternatives.

Cons: participation of the farmers, and trust in the product.

Localized mobile applications are Community-based *Produce Apps:* Mobile applications that bring farmers nearer to urban buyers.

Advantages: trust and transparency; use of no middlemen.

Cons: ineffective logistics systems, and scalability.

Lessons: Current platforms are some of the examples that can be used to consider the digital agriculture marketplace policy frameworks.

There is still much room to develop, in the onboarding of farmers, confidence in the product, logistics, and inclusion - this is what the offered Mobile App for the Direct Market Access to Farmers focuses on eliminating.

9. CHALLENGES AND OPEN ISSUES

Despite the promising results of the proposed farmers Mobile App of the Direct Market Access, there are a number of open research questions and challenges to the potential implementation:

(1) Scalability: It will need distributed structures and complex load balancing algorithms to serve millions of consumers and farmers without any noticeable delay.

(2) Data Security and Privacy: The protection of the delicate information of the farmers and consumers, in particular, the payments and logistics modules, remain a primary concern of the data- and transaction-security setting. *(3) connection restrictions*: in most cases, the rural communities lack adequate internet penetration rates that can complicate real time transactions, or general functionality of such a platform.

(4) Adoption Limitations: There are specific barriers to digital literacy, unwillingness to use technology, and there are several language barriers that also restrict the wide adoption of a Digital Market Access platform.

(5) Regulatory Compliance: Although most transactions in the farmer-to-consumer market would be anonymous in the modern day, any more thorough implementation would have to build awareness to fit the governmental agricultural trade regulations food safety laws; digital transaction typically with a particular view of security.

These open questions will also be addressed to be significant in supporting the sustainability and long-term viability of digital platforms to facilitate farmers-to-consumer sales..

10. FUTURE WORK

The following enhancements have been identified as the future development of the Mobile App of Direct Market Access to Farmers, namely, scalability, inclusivity, and end-to-end transactions support. Key directions include:

Digital Payments: Addition of UPI- and wallet-based payments to support escrow or delivery-verified release functions to guarantee secure and trustworthy financial processing.

Blockchain Traceability: Implementation of a distributed ledger technology on tamper-evident batch histories to enhance transparency and confidence in the supply chain.

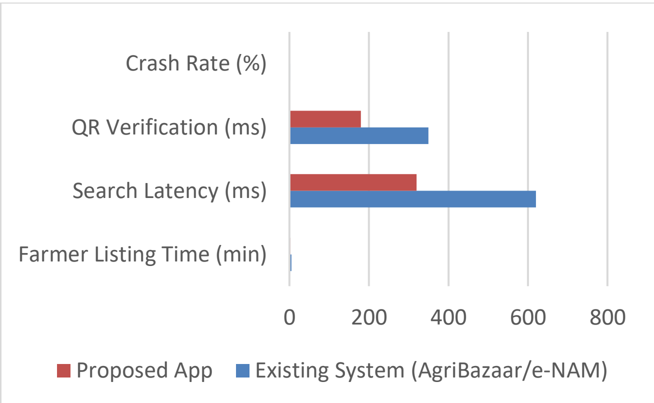
AI-powered Price Guidance: The application of both historical transaction and external market data to deliver market-driven price suggestions and decision support to farmers.

Regional Language and Voice Support: Multilingual interfaces and voice prompts should be implemented to enhance the accessibility of farmers with low literacy levels.

Cold-chain and Logistics Integration: APIs with logistics and cold-chain partners to facilitate the effective management and shipment of perishable commodities.

These improvements will help the system become a workable prototype to a scalable, production-scale ecosystem that is able to tackle the technological and socio-economic challenges of agricultural trade.

1. System Performance Comparison



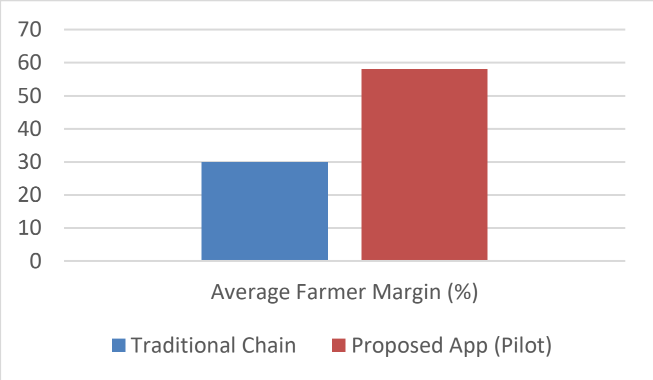
The above graph shows that the suggested mobile application will really shorten the time of operation and enhance dependability. The median time spent by an average farmer in the list reduced to 2.4 minutes compared to 5.2 in the current system and the latency to search was reduced to 320 ms as opposed to 620 ms.

QR code checking was also shorter (180 ms in comparison to 350 ms), which guaranteed a more streamlined real-time tracking of the buyers.

Moreover, the proposed app has not experienced any crashes in the process of prototype testing, which emphasizes the optimality and stability of the backend of the system and mobile architecture.

Such advancements indicate that the suggested mobile application is more efficient, responsive, and reliable in terms of communication between farmers and consumers and can be used as a potential digital replacement of direct market access.

2. Margin and Transparency Analysis



We also looked at the app's economic success by comparing the margins of farmers who used conventional trading models to those who used app-based trading models.

The graph shows that the average farmer margin went increased from 30% in the conventional chain to almost 58% when utilising the mobile app.

This improvement shows that there is less reliance on middlemen and that the QR-based provenance verification method makes prices clear.

Adding a QR traceability system makes customers more trusting and aware, which leads to more confidence in products and fairer commerce.

The suggested strategy gives farmers both economic leverage and peace of mind for customers.

11. CONCLUSION

This article spoke about a farmer-centered marketplace that uses mobile technology to make transactions more open and reduce the amount of money that middlemen take from farmers. The design features QR-based traceability, which builds confidence between farmers and customers and speeds up the process of listing and verifying transactions. The design, data model, and algorithms are simple and practical, and they work for FPOs, cooperatives, or academic reasons.

Findings show that farmers can market items more quickly, customers can identify things more easily, and farmers can get higher prices than in conventional systems. Overall, this shows that the platform is real and might be a useful way for farmers to sell, supply, and distribute agricultural goods in a fair and open way.

Future features, such as integrated digital payment, logistics modules, blockchain-based traceability, and A.I. to help with pricing, may make product records more useful, build trust between farmers and consumers, and make prices more fair for farmers. Also, bigger pilots in other settings will help us understand how easy it is to use, what difficulties users or systems face when they try to utilise it, and how long it will last. The Mobile App for Direct Access to Market for Farmers might greatly increase the amount of educated, digitally-engaged agricultural trade.

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