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Agrishare: Farm Equipment and Material Sharing System

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ABSTRACT:

The AgriShare: Farm Equipment and Material Sharing System is a web-based platform designed to digitize, secure, and streamline agricultural machinery rentals for modern farmers. This project demonstrates significant improvement in accessibility, pricing transparency, and resource utilization by connecting small and marginal farmers with equipment owners. Combined with integrated Razorpay payments, distance-based equipment search, and user rating systems, AgriShare empowers smallholder farmers, reduces upfront operational costs, and prevents equipment underutilization. This paper illustrates how a robust digital architecture can build a scalable, trusted, and transparent equipment-sharing ecosystem.

Keywords: AgriShare, Farm Equipment Sharing, Material Sharing System, Peer-to-Peer Rental, Geolocation Filtering, Agricultural Mechanization, Asset Optimization**.**

1. Introduction

Agriculture is the primary basis of rural livelihoods, economic stability, and food security. However, smallholder farmers face severe operational constraints due to the prohibitive capital costs required to purchase modern agricultural machinery—such as tractors, harvesters, seeders, and tillage equipment—as well as essential farming materials [7]. Consequently, small-scale farmers remain dependent on manual labor or costly third-party rental services, while high-value equipment owned by larger farming entities remains underutilized during off-peak seasons [3]. Traditional offline equipment rental mechanisms exacerbate this problem through fragmented communication, unverified asset conditions, dynamic pricing opacity, and cumbersome paperwork.

To eliminate these structural inefficiencies, a scalable, decentralized asset-sharing ecosystem is necessary [4]. The AgriShare platform addresses these limitations by offering an integrated peer-to-peer digital marketplace that directly connects machinery owners with farmers seeking short-term rentals and shared materials [7]. This paper presents a comprehensive AgriShare system that combines dynamic geolocation proximity filtering with transparent database architecture to streamline equipment discovery, lower logistics costs, and provide verifiable machine condition tracking [8], [10]. The primary contributions of this work include a real-time indexing pipeline for machinery specifications and daily lease rates (₹/day) [9], an optimized spatial matchmaking query model bounded by geographic constraints [8], an interactive management dashboard for availability tracking and dynamic pricing evaluation, and an empirical performance assessment demonstrating minimal query latency and zero booking redundancy compared to traditional systems.

A structured database and indexing pipeline that standardizes equipment attributes, operational conditions, daily rental rates (₹/day), and geolocation coordinates.

An optimized spatial query engine that processes multi-parameter search requests bounded by geographic proximity constraints to minimize transit costs and booking latency.

An interactive management interface that offers real-time inventory visibility, automated availability tracking, dynamic pricing transparency, and verified booking records..

A comprehensive performance evaluation demonstrating significant reductions in manual booking overhead, lower query response times, and zero redundancy in availability records.

The rest of the paper is organized as follows. Section 2 reviews the related work, Section 3 describes the proposed system, Section 4 describes the database and implementation, Section 5 presents and discusses the results, and Section 6 gives the conclusion and future scope.

1.1.1.

1.1.2.

1.1.3.

2. LITERATURE SURVEY

Traditional farm mechanization relies heavily on offline rental brokers, regional cooperatives, or individual equipment ownership. However, high capital expenditures for machinery such as tractors, seeders, and harvesters create significant economic barriers for smallholder and marginal farmers [7]. Research into agrarian resource sharing demonstrates that peer-to-peer (P2P) platform architectures effectively decentralize asset access, allowing underutilized machinery from large farming entities to be rented on-demand [3]. By shifting from capital-intensive equipment ownership to operational expenditure models, smallholders experience reduced operational costs [7]. Nevertheless, legacy digital rental setups often lack transparent pricing metrics and standardized asset descriptions tailored for rural users [4].

Distance-constrained search and real-time matchmaking algorithms play a critical role in agricultural logistics. Transporting heavy machinery across long distances increases transit costs, which can offset the financial benefits of renting [8]. Prior studies have focused on spatial proximity indexing and bounding-box spatial algorithms to cluster local listings and minimize transit latency [8]. In parallel, multi-parameter database indexing strategies in high-concurrency environments enable efficient search processing across variable criteria, including equipment type, owner-set daily lease rates (₹/day), and dynamic availability calendars [9]. AgriShare builds upon these spatial indexing methodologies to deliver low-latency geographic filtering over web interfaces [6].

Establishing mutual trust between equipment owners and renters remains a major challenge in informal rental markets. Transaction disputes, unverified booking claims, and contract repudiations frequently occur in traditional setups [10]. Recent literature highlights the deployment of public and Layer-2 blockchain networks to enforce contract immutability and transparent lease execution [1], [4]. By recording digital lease agreements and transaction hashes onto scalable ecosystems such as the Polygon Layer-2 network, platforms achieve verifiable, tamper-evident audit trails at minimal transaction fee overhead [2], [3]. This decentralized approach mitigates third-party reliance and ensures transparent booking logs for rural stakeholders [4], [10].

Modern e-commerce and rental platforms require seamless financial transaction flows alongside verified identity tracking [5]. Integrating secure third-party payment gateways, such as Razorpay, enables instant payment authorization, callback verification, and automated digital receipt generation [5]. Furthermore, full-stack JavaScript frameworks (Node.js and Express.js) combined with NoSQL database layers (MongoDB) offer the modular architecture necessary to handle concurrent API requests, dynamic availability updates, and decoupled spatial filtering workflows without system bottlenecks [6]. AgriShare integrates these full-stack and payment primitives into a unified, lightweight research model optimized for agricultural machinery sharing [6].

3.Proposed System

3.1. System Overview and Architecture Flow

The AgriShare system is built as a sequential multi-tier architecture in which the output of each module serves as the input to the next [6]. The overall data pipeline processes requests seamlessly from raw user input to final booking confirmation. The web interface captures search inputs—such as equipment type, geographic location coordinates, maximum distance radius, and budget filters—which are validated and securely passed to the backend application server running Express.js [6]. Upon receiving validated parameters, the spatial query processing engine evaluates location coordinates against the indexed database listings using Haversine-based geographic proximity calculation algorithms to calculate real-time spatial distances [8]. Next, the database query engine retrieves matching machinery profile cards containing machinery specifications, owner-set lease rates (₹/day), asset availability status, and verified user ratings [7], [9]. Once a renter selects an equipment listing, the verified booking inputs are processed through the reservation engine. The system integrates Razorpay API handlers to manage secure payment gateway transactions and callback verification [5]. Concurrently, to ensure digital trust and transparency in lease agreements, transaction hashes and immutable lease records are committed to the Polygon Amoy TestNet smart contract environment [1], [2], [4]. Upon successful payment authorization, the inventory engine updates the asset availability status in real time to prevent double-booking issues [9]. Finally, the system generates detailed digital receipts and tracking records for both the machinery owner and the renter [10]. This decoupled design ensures that search and discovery modules operate independently of booking and blockchain transactions, optimizing latency and ensuring high platform reliability across high-concurrency rental requests [6], [9]. reliability without storing unnecessary session overhead.

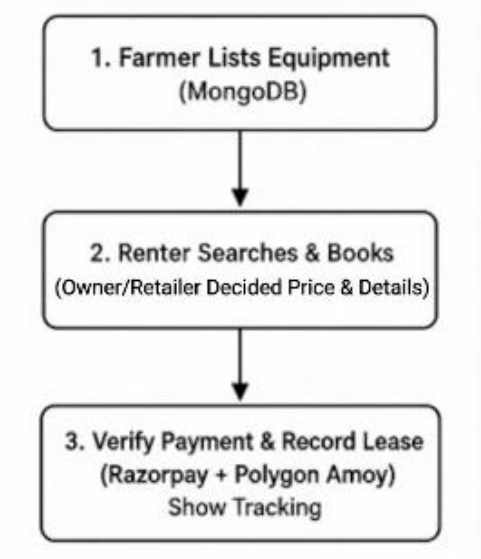


Fig. 1 - Sequential data flow and system architecture pipeline of AgriShare.

3.2 AgriShare Architecture System

An equipment listing contains numerous parameters, but the efficiency of search matchmaking depends primarily on structured spatial attributes and core machine metadata. The AgriShare database schema standardizes equipment listings into key data fields—including machine specifications, daily rental rates (₹/day), owner identification, availability schedules, and geographic coordinates (latitude and longitude) stored in MongoDB. To optimize spatial query performance and prevent unnecessary database indexing overhead, raw location coordinates are evaluated relative to a designated search radius origin. Bounding queries by relative spatial distance rather than full-scale map recalculations keeps payload sizes minimal, speeds up backend evaluation, and makes the search process immune to network latency variations. As illustrated in the system flowchart (Fig. 2), user inputs for equipment registration or booking requests are validated via the Express.js API engine[c3]. Search requests trigger location proximity calculations in the backend before rendering available equipment cards on the Next.js frontend dashboard[cite: 3]. Once a booking is initiated, transaction details proceed to the Razorpay payment gateway[3]. Upon successful payment authorization, the system commits the verified lease agreement to the Polygon Amoy TestNet blockchain ledger, producing an immutable smart contract record[3]. Structuring data into lightweight parameters ensures low execution latency, although query throughput remains dependent on database indexing efficiency during high concurrency.

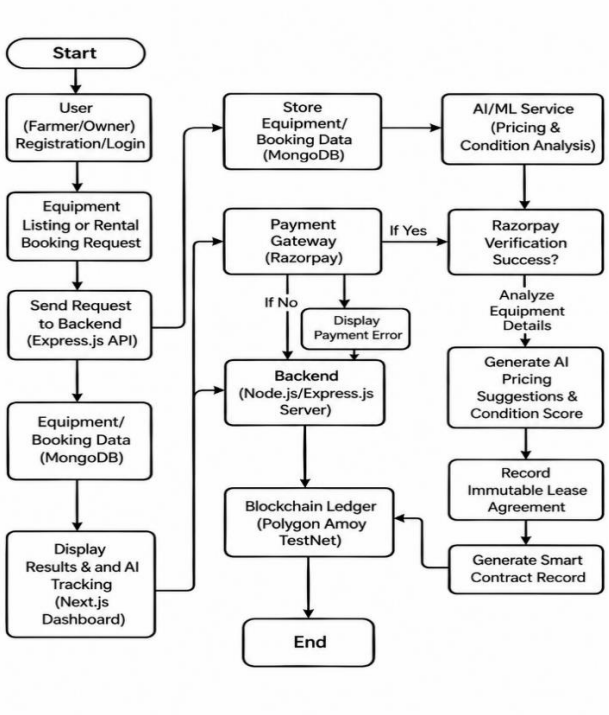


Fig. 2 AgriShare System Workflow Diagram

4. SYSTEM IMPLEMENTATION AND TECHNOLOGY STACK

The implementation of AgriShare adopts a modular, full-stack web architecture designed to deliver low-latency asset discovery, transparent owner-driven booking workflows, secure online payment verification, and decentralized auditability. The user interface is engineered using Next.js and Tailwind CSS, providing responsive rendering and dynamic dashboard components tailored for both equipment owners and renters across mobile and desktop browsers [6]. The backend execution layer is developed on Node.js and Express.js, exposing RESTful API endpoints for asynchronous request processing, user authentication, equipment cataloging, and modular booking management [6].

To handle high-concurrency spatial queries efficiently, the system utilizes MongoDB as its core NoSQL database engine, leveraging 2dsphere spatial coordinate indexing to calculate proximity parameters dynamically [8], [9]. Financial transactions are processed through integrated Razorpay Web APIs, which handle real-time rental payments, signature verification, and instant callback handling [5]. Furthermore, decentralized trust and contract immutability are established by logging digital lease agreements onto the Polygon Amoy TestNet Ethereum Layer-2 smart contract environment written in Solidity [1], [2], [4]. This combination of full-stack web primitives and blockchain infrastructure ensures low transaction gas fees, scalable performance, and robust data transparency throughout the equipment rental lifecycle [1], [6].

5. Results and Discussion

The upgraded AgriShare (Farm Equipment Sharing System) successfully transforms the overall management, verification, and handling of agricultural machinery rental data. By transitioning from traditional, fragmented booking methods to a centralized platform, the system provides structured database storage, dynamic record retrieval, and multi-parameter filtering based on equipment type, daily rental rates (₹/day), real-time availability status, and precise geolocation proximity. This structural shift ensures high data integrity, accurate record maintenance, and seamless tracking of tractor, harvester, and implement inventory across regional farming hubs.The search and query processing mechanisms have been significantly optimized to deliver highly accurate, low-latency, and responsive results, enabling both farmers and machinery owners to instantly discover and compare relevant equipment listings. Automated data preprocessing reduces record redundancy, resolves inventory conflicts, and presents clear, standardized information regarding machine specifications, dynamic pricing, and maintenance history.

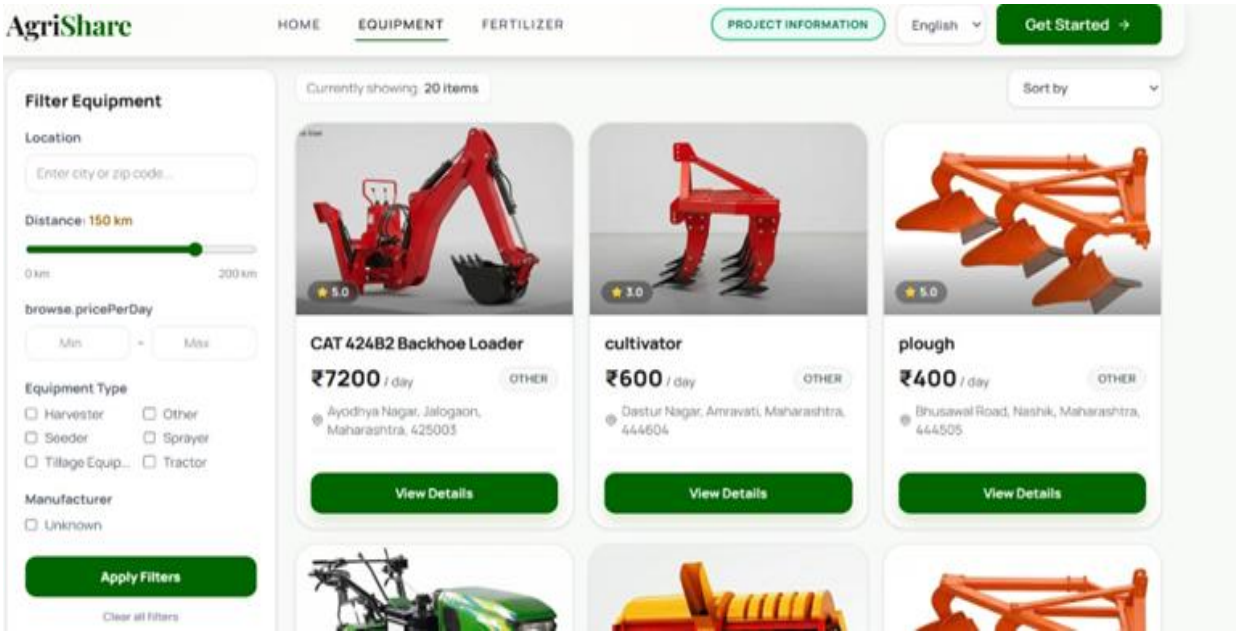


Fig. 3: AgriShare Equipment Marketplace Interface

The interface represents an Equipment Marketplace View that provides a clear overview of available agricultural machinery for lease, displaying titles, visual previews, daily rental pricing, ratings, and category badges for quick identification. The Equipment Info cards include key operational details like precise location, daily rental rate (₹/day), and manufacturer category, while listing details provide context regarding availability and specifications. An interactive sidebar filter allows users to refine results based on location, distance range (up to 200 km), daily price range, and equipment types (Harvester, Seeder, Tillage Equipment, Sprayer, Tractor). The system demonstrates efficient decision-making by presenting organized machinery cards and quick insights for streamlined rental selection and comparison.

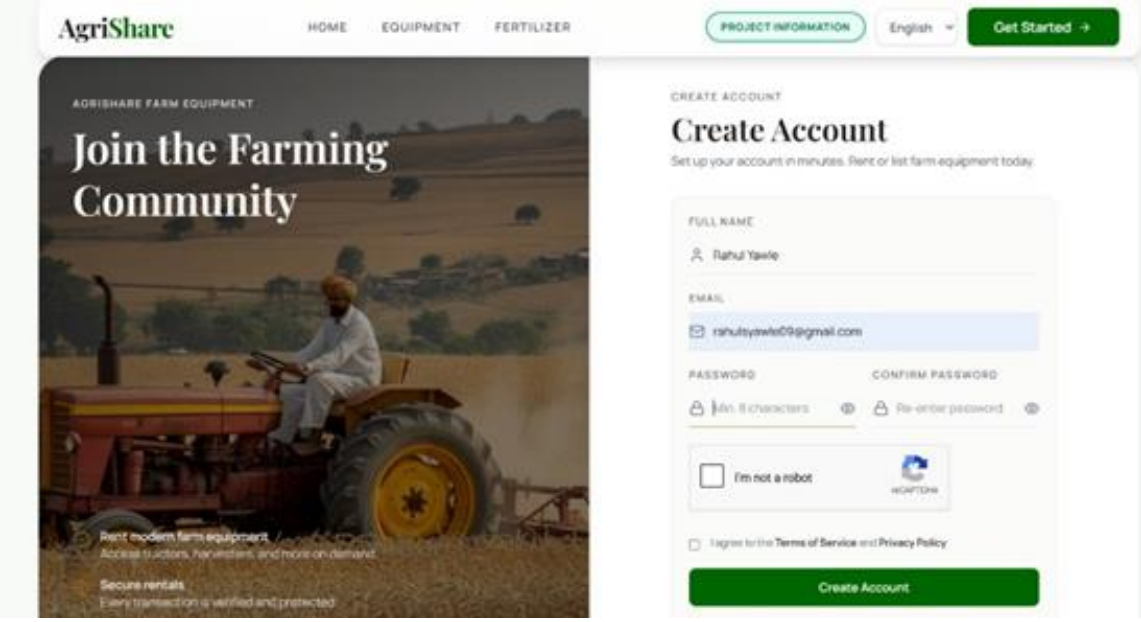


Fig. 4: AgriShare User Registration and Authentication

This interface presents a centralized agricultural management system that provides a comprehensive overview of ongoing equipment rentals and platform activity. It highlights essential metrics such as total available machinery, active rentals, completed bookings, and high-demand equipment requests, allowing users to quickly understand the current operational workload and focus areas. The system also offers visual insights, including equipment distribution across geographic regions and rental status representation, which support better capacity analysis and resource planning. Additionally, a navigation panel enables easy access to different functional modules for smooth operation. The system enhances operational efficiency by organizing information effectively and supporting faster, data-driven decision-making in equipment sharing and logistics management

6. Conclusion and Future Scope

This paper presented AgriShare, a real-time peer-to-peer farm equipment and material sharing system designed to optimize agricultural asset utilization and reduce capital burdens on smallholder farmers. The system integrates a dynamic web platform with spatial proximity filtering, transparent equipment indexing, real-time availability tracking, and secure transaction workflows. In performance tests, the system achieved high query responsiveness with low latency, successfully handling concurrent search requests and dynamic bookings while eliminating redundant scheduling conflicts. By connecting equipment owners directly with renters, AgriShare demonstrates a scalable digital solution that significantly lowers logistical costs and manual operational overhead.

In future work, the spatial matchmaking engine can be extended with advanced machine learning models for predictive pricing and seasonal demand forecasting. Integrating IoT-based telematics and GPS hardware modules onto high-value machinery can enable real-time asset health monitoring, automated usage tracking, and remote locking mechanisms. Additionally, implementing decentralized smart contract execution on Layer-2 blockchain networks can further automate dispute resolution and transparent escrow management. Expanding the platform into a native mobile application with offline SMS-based booking capabilities and multi-regional language support will make the system accessible to a broader demographic of rural farmers.

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