Tech-Enabled Agro-Rental Service for Uplifting Economically Weaker Farmers Through Shared Resources with chatbot

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***Abstract*—India's rural economy still depends heavily on agriculture, but small and marginal farmers still face difficulties because of their lack of access to modern equipment, fragmented markets, and trustworthy advice services. Farmers are frequently prevented from employing necessary tools at the appropriate time by high equipment costs and reliance on landlords or middlemen,which eventually affects output. By putting up a technology-driven agro-rental solution that democratizes access to farming equipment and online marketplaces, our project tackles these persistent issues. Economically disadvantaged farmers can easily hire farm equipment at reasonable prices because to the suggested system's unified digital platform. Equipment owners can list their tools using a shared-resource approach, and farmers can find and reserve them based on location and availability. Economically disadvantaged farmers can easily hire farm equipment at reasonable prices because to the suggested system's unified digital platform.**

Keywords— Equipment rental system,Agricultural advisory chatbot,ML in agriculture,Ollama deployment,Geo-location based services

I. INTRODUCTION

The majority of people in India rely either directly or indirectly on agriculture for their living, making it one of the country's most important economic pillars. Despite its importance, the agriculture industry nevertheless faces enduring problems that impede growth and productivity, particularly for small and marginal farmers. [1] Farmers' adoption of effective agricultural practices is severely hampered by fragmented market systems, limited access to modern equipment, and a lack of timely support. Consequently, the industry faces lower yields, more operational reliance, and lower profitability.The difficulty of economically disadvantaged farmers to purchase necessary agricultural equipment, such as tractors,rotavators, sprayers, and harvesters, is one of their biggest problems. [2]

Farmers find it challenging to purchase or sell necessary agricultural inputs since rural agricultural market places are still underdeveloped. The lack of organized digital channels makes it difficult for small-scale vendors of seeds,fertilizer, and farm equipment to reach a large consumer base. Additionally, farmers lack access to verifiable information on product availability, pricing, and quality, which causes them to make poor decisions that affect the health of their crops and their financial results. The necessity for a single digital platform that can close current gaps in agricultural commerce is highlighted by this disparity between buyers and sellers. [3]

In addition to these structural difficulties, farmers must overcome a significant knowledge gap in order to obtain timely and precise agricultural advice. In rural locations, there is limited access to crop-specific advice, pest management strategies, fertilizer recommendations, and weather based insights.to modernize agriculture. [4] Digital technology improvements have made it feasible to develop integrated plat forms that combine marketplace services, equipment rental, and AI-driven guidance into a single system. By allowing farmers to rent contemporary equipment at reasonable prices, obtain necessary agricultural supplies, and obtain dependable agricultural support, a tech-enabled agro-rental business can dramatically close the digital divide.

Such technologies can empower rural agricultural communities and support the goal of a more accessible and effective agricultural ecosystem by integrating location-based services, digital payments, and user friendly interfaces.By merging shared-resource methods, e-commerce capability, and intelligent chatbot-based help, the suggested platform seeks to address these persistent problems. It offers a transparent, scalable and farmer-focused system that links farmers, agricultural vendors, and equipment owners on a single digital network .Additionally, the government's overarching goal of advancing digital agriculture and sustainable rural development is in line with the integration of this tech-enabled agro-rental platform. Farmers are better equipped than ever to use digital solutions that streamline their everyday operations thanks to the rising smartphone adoption and enhanced internet connection in rural areas.

Even new users are encouraged to participate digitally by the platform's user-friendly layout,linguistic assistance, and safe transaction methods. [5] In addition to improving operational effectiveness, this greater digital inclusion boosts the rural

economy by empowering farmers to make data-driven decisions, implement contemporary farming techniques, and take advantage of previously unattainable opportunities.

II. BACKGROUND STUDY

Agriculture has consistently been integral to India's economic structure, with over 60% of the population relianton farming for their livelihoods. Despite this extensive dependence, a considerable number of farmers continue to be economically disadvantaged due to insufficient access to con temporary agricultural machinery and timely supplies. Mech anization, vital for enhancing efficiency and output, remains predominantly accessible to medium and large-scale farmers capable of affording the substantial costs associated with equipment ownership. Small and marginal farmers, constitut ing the majority, frequently lack the financial means to acquire machinery such as tractors, rotavators, harvesters, or sprayers due to substantial capital investment and ongoing maintenance expenses. Historically, farmers rely on local intermediaries or informal leasing networks to obtain equipment. [6].

Further more, rental agreements are typically verbal, which can result in conflicts and exploitation. This mismatch greatly effects agricultural productivity and overall profitability.Along with equipment accessibility constraints, the agricultural supply chain in rural areas remains fragmented. Farmers, especially those from outlying districts, find it difficult to obtain critical farming inputs such as seeds, fertilizers, insecticides, and minor tools. Sellers and local vendors also struggle to reach larger customers owing to regional constraints and limited ex posure.The absence of timely agricultural guidance is another major issue that farmers must deal with. Due to a 75% lack of agricultural officers, a lack of extension services, and a reliance on antiquated methods, many rural areas have little access to professional advice. Weather fluctuations, pest outbreaks, and soil nutrient imbalances require immediate attention, but farmers often lack a reliable source of information.

This knowledge gap leads to incorrect decisions regarding crop selection, fertilizer dosage, pest management, and irrigation cheduling, hampering productivity and sometimes causing economic losses. With increasing technological advancements and rapid digitalization across sectors, agriculture has begun adopting modern solutions such as mobile apps, online market places, and AI-driven advisory tools. Studies have shown that digital platforms for equipment renting and agri-commerce greatly improve transparency, process efficiency, and farmer selection

III. PROPOSED METHODOLOGY

The methodical approach used to design, develop, and implement the Tech-Enabled Agro-Rental platform integrated with an AI-based chatbot is described in the suggested methodology. Requirement analysis, system design, architec- ture development, module implementation, and performance evaluation are all covered by the methodology's several stages. Every stage guarantees that the platform stays scalable, user- focused, and appropriate for rural agricultural settings. [8]

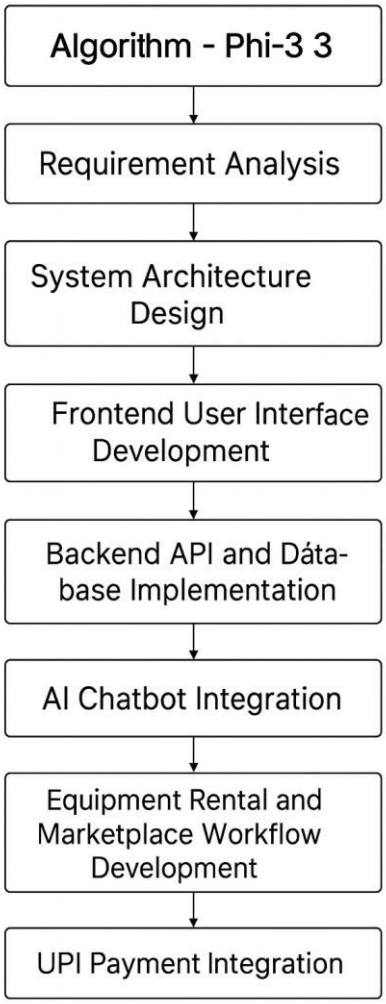

Fig. 1. Methodology Flowchart

A. Algorithm Used:Phi-3
Mini Model for Agri-Chatbot.

The Phi-3 Mini Model, a lightweight yet powerful Large Language Model (LLM) tailored for local execution, powers an AI-driven chatbot in the suggested system. Phi-3 is specifically made for edge deployment, allowing for natural language processing, context comprehension, and intelligent reasoning without the need for GPU servers or cloud reliance. Because of its small size, it may be used in rural areas with limited internet connection, providing farmers with quick and affordable conversational support. The Ollama runtime is used to deploy the model locally, guaranteeing offline functionality and privacy. To customize the model's response style, domain-specific agricultural prompts are offered.User inquiries about crop management,fertilizers, pest control, equipment recommendations, seasonal planning, and other topics are processed by the model.Because of the model's quantized architecture and optimized inference speed, responses are produced in less than a second.

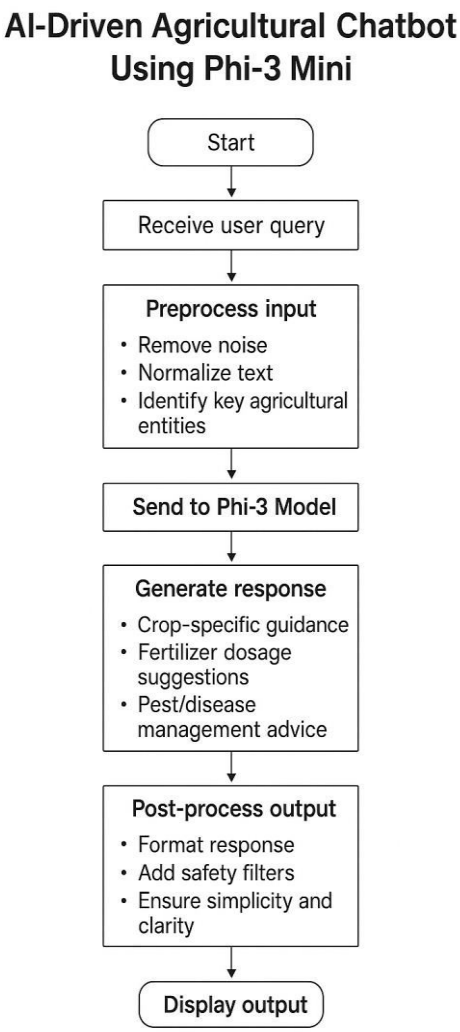

Fig. 2. Phi-3 algorithm

B. Why Phi-3 Was Chosen

Minimal processing power → operates seamlessly on local systems High capacity for reasoning in comparison to comparable small models Quick inference is perfect for conversations with chatbots in real time. For rural locations with poor connection, offline help is essential. Domain-specific prompt engineering is supported via customizability. Economical: no need for a cloud subscription

C. Requirement Analysis

The first step in the development process is to determine the main obstacles that farmers, equipment owners, and agri-vendors must overcome. Functional needs include equipment rental management, agricultural commodity buying/selling, user identification, chatbot interaction, and UPI-based payment integration. Non-functional needs like as scalability, low latency replies, mobile friendliness, and data security are also examined. This stage guarantees that the solution supports simple adoption and is in line with the requirements of farmers who are economically disadvantaged.

D. System Architecture Design

Following the completion of requirements, a modular and layered method is used to build the system architecture.The architecture includes a frontend interface, backend REST APIs, MongoDB storage, AI chatbot module, and payment integration layer. Data flow diagrams, sequence diagrams, and ER-models are produced to map workflows such as equipment listing, booking, product checkout, and chatbot queries. This design process promotes clarity, modularity, and future scalability of the platform. [9]

E. Frontend User Interface Development

To make the frontend responsive, user-friendly, and mobile friendly for farmers, HTML, CSS, and JavaScript are used in its development. Simplicity and usability are focused to accommodate individuals with limited digital literacy. Com ponents such as login pages, marketplace views, equipment listing forms, cart interfaces, dashboards, and chatbot windows are built with straightforward navigation and short learning curve. [10]

F. Backend API and Database Implementation

In this stage, Node.js and Express.js are used to create backend services. Registration, login, equipment posting, product listings, booking administration, and search are all handled by APIs. Chat logs, transactions, equipment information, and user data are all stored in MongoDB. Geospatial indexing is employed to facilitate location-based filtering, guaranteeing that farmers may find local tools and agricultural supplies easily. [11]

G. AI Chatbot Integration

The Phi-3 model, which is implemented via the Ollama runtime, is used in the development of the agricultural advisory chatbot. Custom prompts and domain-specific instructions are designed to assure high-quality responses pertaining to crop choices, fertilizer usage, pest control, and equipment recommendations. The chatbot is connected with the frontend interface so that farmers may obtain instruction promptly. By taking this step, the platform becomes an intelligent farming helper instead of just a transactional system. [12]

H. Equipment Rental and Marketplace Workflow Development

Key processes are created and put into action, including seller dashboard statistics, marketplace product purchases, equipment rentals, and availability checks. Date-based booking logic prevents double-booking of equipment, while cart and order modules control product transactions. Through analytics dashboards, sellers may analyze previous rents or sales, alter listings, and monitor revenue. This enables smooth end-to-end functionality across all user roles. [13]

I. UPI Payment Integration

The platform implements UPI deep links to facilitate secure, fast, and user-friendly payments. When a farmer proceeds to checkout, a dynamic UPI link or QR code is generated with details such as amount, payee ID, and transaction note. The system also handles callback responses to verify transaction status and update booking or order records. This integration enhances trust and reduces dependency on cash transactions.

J. Testing, Validation, and Performance Analysis

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Following development, the system is put through user acceptability, integration, and unit testing. Backend APIs are load tested using JMeter to guarantee steady performance under high usage. Lighthouse tests examine UI performance and responsiveness. Various farming criteria are used to quantify chatbot accuracy and latency. All test results are logged and analyzed to develop and optimize the system further.

K. Deployment and Maintenance

The finished solution is hosted on cloud platforms, ensuring high availability, scalability, and real-time access. Environment variables, database connections, security restrictions, and monitoring tools are configured to maintain the system reliable. Future improvements such as multilingual support, mobile app development, IoT integration, and AI-based suggestions can be introduced thanks to the modular architecture.

a) Positioning Figures and Tables: The TABLE 1

The primary characteristics of your AgroHub platform are outlined in the table. It describes each feature, the data it offers, and the reasons farmers might benefit from it.The AI Recommendations row demonstrates how the system helps farmers make informed decisions by providing weather updates, crop recommendations, and care advice.In order to help farmers or equipment owners understand earning potential, the Equipment Rental Insights row describes how the platform offers rental prices, demand, and profit calculations.The marketplace part where pesticides and inputs are listed with price and availability, making it easier for farmers to purchase what they need, is described in the Agri Bazaar Products row.

Features	Description	purpose
AI Recommendations	Weather,crop suggestion,care products	Helps plan effectively
Uipment Rental Insights	Rental orice,demand %,monthly annual profit	Helps owners earn more from equipments
Agri Bazaar Products	Pesticides with price,stock status,and location	Supports easy purchase of farm essentials

TABLE 1 . OVERVIEW OF AGROHUB APPLICATION FUNCTIONAL MODULES

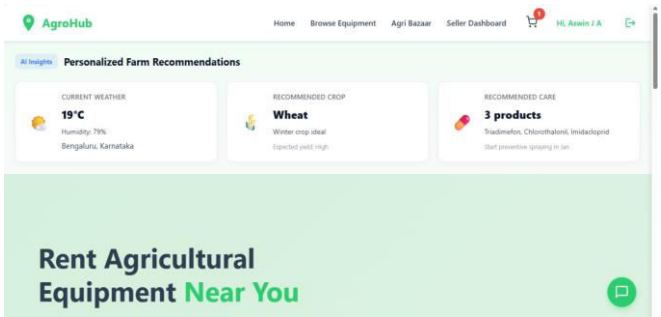

Fig. 3. Personalized Farm Recommendations (AI Insights)

AI Insights [fig3]:The dashboard gives individualized farm recommendations using AI insights, starting with the current weather, which indicates 19°C temperature and 79 percent humidity in Bengaluru, Karnataka. This meteorological data aids farmers in efficiently organizing their farming operations.The system suggests wheat as the best crop based on the winter season, pointing out that a high yield is anticipated.It lists three key products triadimefon, chlorothalonil, and imidacloprid along with crop recommendations and suggested maintenance. These goods aid in defending the crop from illnesses and pests. Additionally, the platform suggests that farmers start preventive spraying in January.All things considered, the dashboard helps farmers by providing precise weather information, appropriate crop selections, and crucial maintenance advice to enhance farming results.

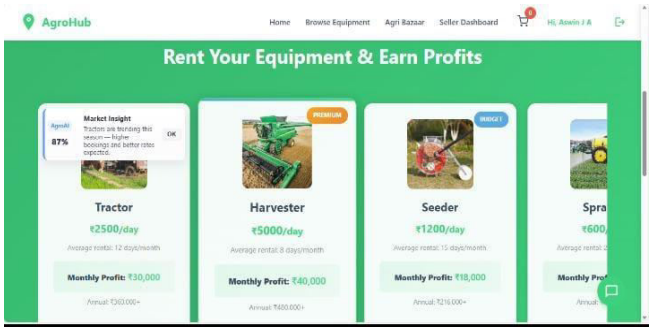

Fig. 4. Rent Your Equipment Earn Profits

Rent Your Equipment [fig4]: The page lists various farming equipment that owners can hire out to make money. Each equipment card indicates the daily rental price, average rental days per month, and the estimated monthly or yearly income.The tractor has great demand this season, but the harvester is touted as a luxury alternative with the highest earnings.The sprayer offers reliable monthly rents, while the seeder is advertised as an affordable option. All things considered, the section aids users in understanding which machinery can make the most money using the AgroHub platform. [14]

Agri Bazaar [fig5]: The picture shows a section of the AgriBazaar with several agricultural pesticides that may be bought.The item's picture, name, category, and location are displayed on each product card. Prices and the status "In Stock" are both prominently displayed in rupees. Products like triadimefon, imidacloprid, and chlorothalonil can be easily added to a user's cart. In general, the interface seems like an online marketplace made to make it simple for farmers to purchase necessary agricultural inputs. [15]

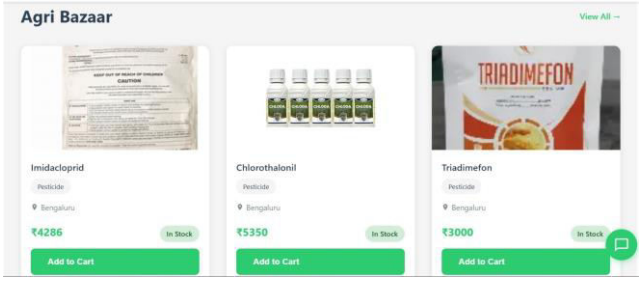

Fig. 5. Agri Bazaar

Dashboard analytic [fig6]: Understanding which agricultural equipment makes up the most portion of the platform's revenue is made easier by this revenue distribution analysis. The software can prioritize inventory, marketing, and maintenance efforts by recognizing high-revenue categories like harvesters and tractors. Additionally, it aids in making strategic decisions like where to grow services or make investments. "Others" and sprayers are examples of low-revenue divisions that may require price modifications or marketing initiatives. In general,this study enhances the effectiveness of agro-rental businesses and encourages better financial planning. [16]

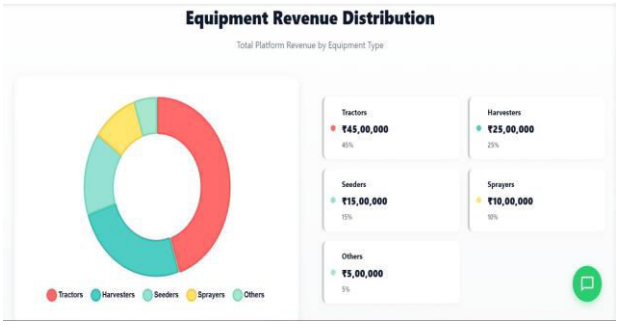

Fig. 6. Dashboard Analytics View

IV. RESULTS AND DISCUSSIONS

The suggested Tech-Enabled Agro-Rental Service was successfully put into practice and tested across a number of functional modules, proving its usefulness for farmers, equipment owners, and vendors of agricultural products. The results indicate that the platform efficiently accomplishes its core purpose of offering economical machinery access, transparent marketplace transactions, and rapid agricultural advise using an AI-powered chatbot. Usability, performance, and applicability to actual rural agricultural demands were taken into consideration when evaluating each module.

A. Platform Usability and User Experience

Usability testing revealed that the system's interface was intuitive, responsive, and easy to navigate, even for users with minimal digital exposure. Farmers were able to browse equipment, check availability, and make reservations with minimal guidance. The marketplace layout, search filters, and simple language labels enhanced overall user experience. Mobile-based testing further confirmed that the platform performed well on low-end devices and scaled effectively across different screen sizes, supporting rural accessibility.

B. Equipment Rental Module Performance

The equipment rental module demonstrated steady performance, allowing users to hire instruments without discrepancies or double-booking concerns. Conflicts were avoided during periods of high demand thanks to the dependable performance of the date-based booking logic. Geolocation-based filtering dramatically enhanced search efficiency by displaying equipment solely from local sellers, lowering transportation obstacles. Compared to more conventional informal renting techniques, the system was more transparent because to automated listing administration and real-time updates for rental owners.

C. Marketplace Efficiency for Agri-Products

Farmers were able to easily compare costs and make purchases while sellers were able to display goods including tools, seeds, and fertilizers thanks to the digital marketplace function. The system recorded rapid loading times and low delays during cart operations and checkout processes. The seller dashboard, which provided information on product performance and revenue history to aid in inventory and pricing strategy planning, was well-received by vendors. This module illustrated the potential to digitalize rural commerce by linking customers and vendors more efficiently.

D. Performance of the AI Chatbot

When it came to answering questions about agriculture, the integrated AI chatbot (powered by Phi-3 on Ollama) performed admirably, providing precise and context-aware recommendations. During testing, the chatbot gave highly accurate advice on crop management, pest control, seasonal planning, and fertilizer recommendations. Response times averaged ¡ one second in local deployment, making it ideal for real-time application even in low-bandwidth settings. Farmers notably benefited from immediate advice that usually required professional consultation, reducing rely on traditional agricultural officers.

E. System Performance and Load Testing

Backend APIs developed with Node.js and Express.js were tested using JMeter under varying loads. The system handled concurrent requests efficiently, with average response times remaining within acceptable limits even under simulated heavy usage. MongoDB demonstrated high throughput during data reads and writes, especially while filtering location-based results. Lighthouse audits performed on the frontend confirmed strong performance scores for accessibility, SEO, and responsiveness. Overall, the platform exhibited excellent stability and scalability.

F. Payment Workflow Results

Several test transactions using apps like Google Pay, PhonePe, and Paytm were used to assess UPI deep-link interoperability. Correct booking confirmations were ensured by the successful generation of payment requests and the precise recording of callback responses. The digital payment method reduced reliance on currency and increased transaction transparency. This feature also improved trust among consumers who were initially reluctant but later found the process swift,secure, and easy.

G. Impact and User Feedback

A high degree of satisfaction with the platform's features was shown by user feedback gathered through informal pilot testing. Farmers reported better access to contemporary technologies, fewer operational delays, and enhanced decision making as a result of chatbot suggestions. Due to improved visibility and organized booking schedules, equipment owners saw an increase in rental income. Vendors of agricultural products profited from increased sales and a larger clientele.These results cumulatively support the platform's ability to elevate economically weaker farmers and strengthen rural digital ecosystems.

V. CONCLUSION

The suggested tech-enabled agro-rental platform successfully increases economically disadvantaged farmers' access to equipment, agricultural supplies, and professional advice. The solution increases efficiency and lessens reliance on conventional middlemen by combining equipment leasing, a digital marketplace, and an AI-powered Phi-3 chatbot. Even in remote locations, the platform's modular architecture guarantees scalability, effectiveness, and user-friendliness. Strong system performance, quick response times, and favorable user acceptability are confirmed by testing findings. All things considered, the solution supports digital agriculture and gives farmers the ability to make prompt, data-driven decisions.Future improvements like IoT-based smart farming, mobile applications, and multilingual support are made possible by this project.

VI. FUTURE SCOPE

To increase accessibility for farmers using smartphones, the platform can be expanded into a feature-rich mobile application. To improve usability and reach farmers in other states, multilingual support can be implemented. IoT sensor integration can make it possible to monitor soil, weather, and crop conditions in real time for more precise advising support. Predictive analytics based on machine learning can predict market trends, pest outbreaks, and crop yields. To make product distribution and equipment transportation more efficient, logistics and delivery modules might be implemented. Future collaborations with governmental organizations and farming cooperatives may increase the system's influence and reach.

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