

Innovation and Entrepreneurship Research on an Agricultural Product Traceability and Precise Production-Sales Matching Platform Based on IoT+AI

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Abstract: Against the backdrop of the digital rural strategy and agricultural modernization transformation, issues such as disjointed production and sales of agricultural products, imperfect traceability systems, and lack of quality trust have severely restricted agricultural industrial upgrading. This paper proposes the "Zhinong Cloud Chain" innovation and entrepreneurship project, constructing an agricultural product traceability and precise production-sales matching platform based on IoT + AI. By collecting full industrial chain data through IoT devices, relying on AI algorithms to achieve intelligent matching of production and sales needs, and combining blockchain technology to ensure tamper-proof traceability information, an integrated solution covering "production-monitoring-traceability-sales" is formed. The research analyzes the project's technical architecture, business model, market prospects, and implementation path, demonstrating the platform's practical value in addressing pain points such as low circulation efficiency of agricultural products and difficulty in ensuring quality and safety, and providing a reference for innovation and entrepreneurship in agricultural digitalization.

Keywords: Internet of Things, Artificial Intelligence, Agricultural Product Traceability, Production-Sales Matching; Agricultural Digitalization.

1. Introduction

1.1. Research Background

China is a major agricultural country, with agricultural product output consistently ranking among the top in the world. However, the agricultural industrial chain has long faced the contradiction between "small-scale production" and "large-scale market". According to data from the Ministry of Agriculture and Rural Affairs, the annual loss rate of agricultural products in China due to poor connection between production and sales is as high as 20%-30%, far higher than the level of less than 5% in developed countries. At the same time, food safety incidents involving agricultural products occur from time to time, and consumers' demand for trust in product origin and production processes is increasingly strong[1]. In the traditional circulation mode of agricultural products, prominent issues such as information asymmetry, broken traceability chains, and delayed supply-demand matching have seriously affected agricultural economic benefits and sustainable development.

With the deep integration of digital technology and agriculture, technologies such as IoT, AI, and blockchain have provided new paths for agricultural industrial upgrading. The "Digital Rural Development Strategy Outline" clearly proposes to "build a smart agricultural system and promote the digitalization of the entire chain of agricultural product production, circulation, and consumption", providing policy support for innovation and entrepreneurship in agricultural digitalization. Against this background, the "Zhinong Cloud Chain" platform uses technological innovation to address pain points in the agricultural industrial chain, with both social value and commercial potential, and has important research and practical significance[2].

1.2. Research Significance

Theoretical Significance: Enrich the theoretical system of innovation and entrepreneurship in agricultural digitalization transformation, explore the integrated application mode of IoT + AI technology in the entire agricultural product chain, and provide empirical reference for academic research in related fields.

Practical Significance: Build a bridge for precise connection between production and sales, reduce agricultural product circulation losses, ensure traceable quality and safety, improve agricultural production efficiency and consumer trust, and contribute to rural revitalization and agricultural modernization.

1.3. Literature Review and Research Content

Significant progress has been made in research and practice concerning the digital transformation of agricultural product traceability and production-sales coordination. However, the existing literature and practical applications reveal distinct limitations and gaps.

Current research predominantly focuses on the isolated application of specific technologies or the optimization of individual segments of the agricultural supply chain. Technologically, numerous studies have explored the value of the Internet of Things (IoT) for environmental monitoring, blockchain for ensuring data immutability, or artificial intelligence (AI) for consumer market forecasting. Yet, these technologies are often treated as independent tools rather than being deeply integrated. In terms of application, existing e-commerce platforms primarily address sales channel challenges but typically offer weak traceability functions with limited transparency. Conversely, many standalone traceability systems are designed mainly for government supervision or brand marketing; they are functionally singular

and fail to address the core operational issue of disjointed production and sales for farmers.

Overall, the existing research and practical frameworks suffer from two critical shortcomings: First, there is a "siloeed" approach to technology application. The integration of IoT, AI, and blockchain into a cohesive system that creates a closed-loop data flow and synergistic functionality within a comprehensive platform remains under-explored. Second, there is a "functional fragmentation" in proposed solutions. Traceability systems and production-sales matching platforms often operate independently, leading to a situation where "products with traceability are hard to sell, and platforms that facilitate sales lack robust traceability." This failure prevents the delivery of a one-stop solution that creates value for multiple stakeholders, including farmers, purchasers, consumers, and regulators.

The "Zhinong Cloud Chain" platform proposed in this research aims to address these deficiencies. By integrating IoT, AI, and blockchain technologies, it seeks to construct a comprehensive platform that combines production monitoring, whole-chain traceability, intelligent matching, and regulatory services. This study attempts to bridge both the technological and functional gaps, offering an integrated solution for the digitalization of the entire agricultural product chain.

2. Relevant Theories and Technical Foundations

2.1. Core Theoretical Support

Industrial Chain Integration Theory: Emphasizes integrating resources from all links of the industrial chain to achieve collaborative operation of production, circulation, sales and other links, reduce transaction costs, and enhance the overall competitiveness of the industry. The "Zhinong Cloud Chain" platform breaks down information barriers in the entire agricultural product chain through digital means, which is the practical application of the industrial chain integration theory.

Information Asymmetry Theory: Points out that differences in the degree of information mastery between both parties in market transactions can lead to market failure. Through the traceability system and the public mechanism of supply and demand information, the platform reduces the information gap between production and sales parties, realizing fair transactions and efficient matching[3].

Innovation and Entrepreneurship Theory: Focuses on technological innovation, model innovation, and value creation, emphasizing market demand orientation and solving practical problems through resource integration. With technology integration as the core and business model innovation as the support, the project conforms to the core logic of innovation and entrepreneurship.

2.2. Key Technical Support

Internet of Things (IoT) Technology: Through sensors, RFID tags, UAVs and other devices, real-time collect data such as temperature, humidity, light, soil composition, and logistics trajectory in the links of agricultural product planting, breeding, processing, and transportation, providing a data foundation for traceability and matching.

Artificial Intelligence (AI) Technology: Build a supply-demand matching model based on machine learning algorithms, analyze data such as agricultural product output,

quality, price, market demand, and consumer preferences to achieve precise connection between production and sales; at the same time, detect agricultural product quality through image recognition technology to improve traceability accuracy.

Blockchain Technology: Store the entire industrial chain data on the chain to ensure that traceability information is tamper-proof and traceable, solve consumer trust issues, and build a transparent quality and safety system.

3. Demand Analysis of the "Zhinong Cloud Chain" Platform

3.1. User Needs

Farmers/Cooperatives: Urgently need to expand sales channels, reduce intermediate links, and achieve premium prices for high-quality products; at the same time, hope to improve product competitiveness through standardized production and quality traceability, solving the problems of "difficulty in selling" and "low selling prices".

Purchasers (Supermarkets, Catering Enterprises, E-commerce Platforms): Need stable and high-quality agricultural product supply, reduce procurement costs and quality risks, and hope to quickly find sources that meet demand through precise matching.

Consumers: Pay attention to the quality and safety of agricultural products, hope to obtain information such as product origin, production process, and test reports to achieve assured consumption; at the same time, expect convenient purchasing channels and personalized demand satisfaction[4].

Regulatory Authorities: Need efficient agricultural product quality and safety supervision tools to achieve real-time monitoring of the entire chain and improve supervision efficiency to ensure food safety.

3.2. Industry Pain Points

Disjointed Production and Sales: In the traditional mode, farmers are isolated from market information, and supply-demand mismatch leads to unsalable or shortage of agricultural products, with low circulation efficiency and high costs.

Imperfect Traceability System: Existing traceability systems are mostly concentrated in a single link, with fragmented data, making it difficult to achieve full-chain traceability, and there is a risk of information fraud.

Lack of Quality Trust: Consumers cannot effectively verify agricultural product quality information, have doubts about product safety, and their willingness to consume is affected.

Lagging Supervision Means: Lack of digital supervision tools, making it difficult to achieve real-time monitoring and rapid traceability of the entire agricultural product chain.

3.3. Core Value of the Platform

Precise Matching: Achieve intelligent matching of production and sales needs through AI algorithms, reduce circulation losses, and improve transaction efficiency.

Full-Process Traceability: Build a full-chain traceability system based on IoT + blockchain technology to ensure traceable quality and safety[5].

Cost Reduction and Efficiency Improvement: Reduce intermediate circulation links, lower transaction and supervision costs, and improve the overall efficiency of the agricultural industrial chain.

Trust Building: A transparent information disclosure

mechanism enhances consumers' trust in agricultural product quality and increases product added value.

4. Design and Implementation of the "Zhinong Cloud Chain" Platform

4.1. Platform Architecture Design

The platform adopts a three-level "cloud-edge-terminal" architecture to realize a closed loop of data collection, processing, and application:

Terminal Layer (Terminal): Deploy IoT perception devices, including field sensors, RFID tags, handheld terminals, logistics tracking devices, etc., responsible for collecting real-time data in production, processing, logistics and other links.

Edge Computing Layer (Edge): Deploy edge nodes near production areas to preprocess and real-time analyze data collected by terminals, reduce cloud computing pressure, and ensure data transmission efficiency.

Cloud Platform Layer (Cloud): Includes modules such as data storage, AI algorithm engine, blockchain service, and application service, realizing core functions such as data storage, intelligent analysis, traceability management, and production-sales matching.

4.2. Core Function Modules

Production Monitoring Module: Real-time collect planting/breeding environment data (temperature, humidity, light, soil moisture, etc.) and production operation data (fertilization, pesticide use, irrigation records, etc.), generate standardized production files, and provide a basis for quality traceability.

Traceability Management Module: By scanning the product QR code, consumers and purchasers can view full-chain information from origin to terminal, including production files, test reports, logistics trajectories, etc. Blockchain technology ensures that information is tamper-proof.

Production-Sales Matching Module: Farmers/cooperatives release product information (output, quality, price, listing time), and purchasers release demand information (product category, quantity, quality standards, procurement price). AI algorithms intelligently match based on the needs of both parties, push precise transaction information, and provide services such as online negotiation and order management.

Quality Inspection Module: Through data docking between image recognition technology and third-party testing institutions, realize rapid detection and result disclosure of agricultural product quality. Products that do not meet standards will be warned and restricted from trading.

Supervision Service Module: Provide a data visualization platform for regulatory authorities to real-time monitor the entire process of agricultural product production and circulation, supporting rapid traceability and emergency handling of quality and safety incidents.

4.3. Technical Implementation Path

Data Collection: Select low-power, high-precision IoT sensors to cover key links such as production, processing, and logistics; adopt RFID tags to realize individual product identification, ensuring traceability accuracy to a single product.

Data Processing: Build a big data storage platform based on Hadoop architecture, use Spark for real-time data analysis; train supply-demand matching models and quality inspection

models through the TensorFlow framework to improve algorithm accuracy.

Blockchain Deployment: Adopt a consortium chain architecture, with nodes such as farmers, purchasers, testing institutions, and regulatory authorities participating to ensure the credibility and security of traceability information.

Platform Development: Adopt B/S architecture, supporting web and mobile terminal (APP, mini-program) access, realizing multi-terminal adaptation and improving user convenience.

5. Business Model and Operation Strategy

5.1. Business Model

Core Profit Models:

- **Platform Service Fees:** Charge transaction commissions from purchasers (1%-3% of the transaction volume), provide free basic services to farmers, and charge for value-added services (such as precise promotion, data analysis reports).

- **Technical Service Fees:** Provide customized production monitoring and traceability system deployment services for cooperatives and agricultural enterprises, and charge technical service fees.

- **Government Procured Services:** Provide an agricultural product quality and safety supervision platform for regulatory authorities, and obtain income from government procured services.

- **Advertising and Value-Added Services:** Provide precise advertising services for agricultural input enterprises (chemical fertilizers, pesticides, seeds), and provide value-added services such as logistics and finance (loan connection, insurance services) for users.

Value Network: Build a win-win value network of "farmers/cooperatives-platform-purchasers-consumers-regulatory authorities-partners (logistics, finance, testing institutions)". Through resource integration and collaborative operation, enhance the value creation capacity of the entire industrial chain.

5.2. Operation Strategy

Market Promotion:

- **Short-term (1-2 years):** Focus on pilot areas (counties/cities with a high degree of agricultural industrialization), cooperate with local governments and agricultural cooperatives, provide free platform services for farmers to quickly accumulate user base; sign cooperation agreements with large supermarkets and e-commerce platforms to ensure demand on the procurement side.

- **Mid-term (3-4 years):** Expand platform coverage through word-of-mouth communication and precise marketing; hold production-sales docking meetings and agricultural product exhibitions to enhance platform visibility and influence; launch mobile terminal promotion activities to attract consumer participation.

- **Long-term (5+ years):** Build an agricultural digital brand and expand the national market; cooperate with international purchasers to help agricultural products export.

User Operation:

- **Farmer End:** Provide free training services to guide farmers in using IoT devices and platform functions; establish an integral reward mechanism to encourage farmers to truthfully upload production data; select high-quality farmers and products and give traffic inclination.

- **Purchaser End:** Provide personalized demand matching services to ensure the quality and stability of source supply; establish an integrity evaluation system and give transaction discounts to high-quality purchasers.

- **Consumer End:** Launch activities such as traceability points and referral rewards to improve user activity; regularly release popular science content on agricultural product quality and safety to enhance user stickiness.

Partner Development: Cooperate with logistics enterprises to build an agricultural product cold chain logistics network to ensure product freshness; cooperate with financial institutions to provide production loans for farmers and payment and settlement services for transactions; cooperate with third-party testing institutions to ensure the authority of test data.

6. Market Analysis and Prospect Prediction

6.1. Market Size

With the acceleration of agricultural digitalization transformation, the market demand for agricultural product traceability and production-sales docking continues to grow. According to relevant data, the scale of China's smart agriculture market has exceeded 100 billion yuan in 2023, and the transaction scale of agricultural product e-commerce has exceeded 5 trillion yuan. Among them, the market penetration rate of traceable agricultural products is increasing year by year. It is expected that the transaction scale of traceable agricultural products will reach 800 billion yuan by 2025, and the market space for digital production-sales docking platforms is broad.

6.2. Competitive Analysis

Existing Competitors: Including traditional agricultural product wholesale markets, vertical agricultural product e-commerce platforms (such as Pinduoduo Agricultural Products Festival, JD Farm), and single-function traceability platforms. Traditional markets have prominent information asymmetry issues, e-commerce platforms lack full-chain traceability functions, and single traceability platforms lack production-sales matching capabilities.

Competitive Advantages:

- **Technology Integration Advantage:** Integrate multiple technologies such as IoT, AI, and blockchain to realize the integration of traceability and matching functions, with a high technical barrier.

- **Full Industrial Chain Coverage:** Cover the entire agricultural product chain from production monitoring to production-sales docking and quality supervision, meeting the needs of multiple users.

- **Win-Win Model for Multiple Parties:** Take into account the interests of farmers, purchasers, consumers, regulatory authorities and other parties, building a sustainable ecological system.

6.3. Prospect Prediction

Through technological innovation and model innovation, the platform can effectively address the pain points of the agricultural industrial chain, in line with the national rural revitalization and agricultural modernization strategy orientation. With the expansion of user base and the improvement of brand influence, the platform will achieve large-scale operation. It is expected to cover 2-3 pilot areas in

the short term (1-2 years), serve more than 10,000 farmers, and facilitate transactions of 500 million yuan; cover more than 10 provinces in the mid-term (3-4 years), serve more than 100,000 farmers, and facilitate transactions of 5 billion yuan; in the long term, it will become a leading agricultural digital service platform in China, promoting the agricultural industry towards an efficient, safe, and sustainable direction.

7. Risk Assessment and Response Measures

7.1. Technical Risks

Risk Description: There may be deficiencies in the stability of IoT devices, the security of data transmission, and the accuracy of AI algorithms; the deployment and maintenance costs of blockchain technology are relatively high.

Response Measures: Select mature IoT device suppliers and establish a data encryption and security protection system; continuously invest in R&D to optimize AI algorithm models; adopt a lightweight deployment plan for consortium chains to reduce technical costs; cooperate with scientific research institutions to enhance technological innovation capabilities.

7.2. Market Risks

Risk Description: Insufficient market acceptance, difficulty in changing the traditional transaction habits of farmers and purchasers; competitors' imitation and market space squeezing.

Response Measures: Strengthen market promotion and user training, and demonstrate platform value through pilot demonstrations; establish differentiated competitive advantages and continuously optimize product functions and services; cooperate with the government to obtain policy support and enhance market credibility.

7.3. Operational Risks

Risk Description: It is difficult to guarantee the authenticity of data uploaded by farmers; the imperfect logistics and distribution system affects product supply; it is difficult to coordinate multiple partners.

Response Measures: Establish a data review mechanism, combining automatically collected data from IoT devices with manual verification to ensure data authenticity; deepen cooperation with logistics enterprises to optimize the cold chain logistics network; formulate partner management specifications, clarify the rights and responsibilities of all parties, and establish a coordination mechanism.

7.4. Policy Risks

Risk Description: Adjustments to agricultural-related policies may affect project operation; data privacy protection-related laws and regulations put forward higher requirements for platform data management.

Response Measures: Closely monitor policy dynamics and timely adjust project operation strategies; strictly comply with data privacy protection laws and regulations, establish a compliant data management system, and ensure user information security.

8. Conclusions and Prospects

8.1. Research Conclusions

The "Zhinong Cloud Chain" platform, based on IoT + AI technology, addresses pain points such as disjointed

production and sales of agricultural products, imperfect traceability, and lack of quality trust. By integrating technologies like IoT, AI, and blockchain, it constructs an integrated solution covering "production-monitoring-traceability-sales", achieving precise matching of supply and demand, full-process traceability of quality, and efficient circulation of the industrial chain. The platform's business model is diversified and sustainable, with broad market prospects, and provides a feasible path for innovation and entrepreneurship in agricultural digitalization.

8.2. Future Prospects

In the future, the platform can be expanded and deepened in the following aspects:

Technological Innovation: Continuously optimize AI algorithms to improve the accuracy of supply-demand matching and quality inspection; explore the application of emerging technologies such as 5G and edge computing to enhance platform performance.

Service Expansion: Expand service coverage, not only focusing on agricultural product circulation but also extending to agricultural production materials supply, agricultural technology services, and rural finance to build a comprehensive agricultural digital ecosystem.

Model Replication: Summarize the successful experience of pilot areas, form replicable operation models, and promote them to more regions to drive agricultural digitalization development nationwide.

International Cooperation: Actively explore international markets, help Chinese agricultural products go global, and contribute to the internationalization of agricultural

digitalization.

In conclusion, the "Zhinong Cloud Chain" project, with technological innovation as the core and market demand as the guide, has important practical significance for promoting agricultural industrial upgrading, ensuring food safety, and helping rural revitalization. It is expected to become a benchmark for innovation and entrepreneurship in agricultural digitalization, creating greater economic and social value.

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