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Research on Collaborative Optimization of Agricultural Supply Chain Financing and Traceability - Banking Practice Based On Blockchain &Smart Contracts

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Abstract: *Against the dual dilemmas of difficult financing and insufficient traceability credibility in China's agricultural supply chain, this paper, from the perspective of banks, constructs a collaborative platform of "financing–traceability–industrial services" by integrating technologies such as blockchain and smart contracts. By designing a credible data system, a financing-traceability linkage framework, a full-process data collection scheme and a full-link security system, the paper integrates multi-dimensional data to calculate dynamic credit ratings, and embeds smart contracts to realize the automatic execution of financing approval, traceability incentives and risk early warning, so as to form a positive cycle of "traceability strengthens credit – financing is implemented conveniently – funds feed back traceability". Meanwhile, potential risks are identified from three dimensions: technology, business operation and ecological collaboration, with corresponding countermeasures proposed. This study not only helps banks solve pain points in agriculture-related businesses, but also provides financial and technical support for rural revitalization and the construction of digital countryside.*

Keywords: *Blockchain; Smart Contract; Financing Credit; Agricultural Product Traceability*

1. INTRODUCTION

As an important pillar of the national economy, the stable operation of the agricultural supply chain is directly related to national food security, food safety, and the implementation of the rural revitalization strategy. At present, China's agricultural supply chain is confronted with the dual dilemmas of financing and traceability. On the financing side, small and medium-sized agricultural entities and smallholder farmers generally lack effective collateral, with fragmented and low-transparency operation information. Their credit coverage ratio is less than 30%, and the traditional financing process is cumbersome with an approval cycle of 15–20 working days, resulting in high financing costs. On the traceability side, the full-chain information of agricultural products covering "production–processing–sales" is fragmented into "information islands". Data collected mainly manually is prone to forgery and difficult to trace, and the credibility of platforms is insufficient. This not only restricts the construction of a "high quality, good price" market system, but also indirectly affects the repayment capacity of agricultural entities. These dual dilemmas hinder the upgrading of the agricultural industry and become a core bottleneck for banks to expand agriculture-related financial businesses, leading to prominent "credit reluctance" among banks and limited implementation of inclusive finance in rural areas.

Against the background that the state vigorously promotes the construction of digital countryside and issues policies such as the Digital Rural Development Action Plan to encourage innovation in agricultural supply chain finance, the distributed and tamper-proof characteristics of blockchain, as well as the automatic performance function of smart contracts, provide technical support for solving data trust problems and optimizing credit processes. Exploring the application paths of the two technologies in the agricultural supply chain from the bank perspective can not only help banks alleviate the pain points of information asymmetry, high risks and low efficiency in agriculture-related businesses, and expand the service boundary of inclusive finance, but also promote the digital transformation of the agricultural supply chain and achieve the unity of commercial value and social responsibility, which is of great theoretical and practical significance.

2. PAIN POINTS IN THE FIELD

2.1. Current Situation Analysis

2.1.1. Scale of Agricultural Investment and Financing

From 2019 to 2024, the number of agricultural investment and financing events in China fluctuated and rebounded from 82 to 99, indicating a continuous rise in capital attention to the agricultural sector. The overall investment and financing amount maintained a growth trend but lacked stability. After reaching a peak of 25.186 billion yuan in 2023, it witnessed a slight adjustment. The financing enthusiasm of the industry has been significantly volatile due to factors such as market conditions and policies.

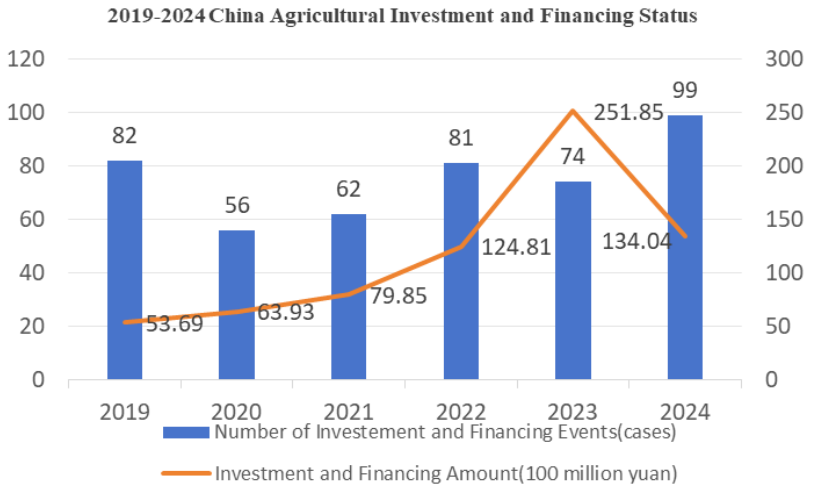

Figure 1. *China's Agricultural Investment and Financing Situation, 2019–2024*

2.1.2. Agricultural Financing Structure

Financing events in the agricultural sector are highly concentrated in early-stage rounds such as angel rounds and strategic investments. Very few financing events occur at the mature stage (Round C and beyond), leading to a serious narrowing of financing channels for enterprises in the later development period. There is an obvious gap in the financing support system covering the entire enterprise life cycle: start-up, growth, and maturity.

2.1.3. Inclusive Financial Services for Farmers

The coverage of financial services for Chinese farmers is far lower than that of the United States. Only 3% of farmers purchase agricultural materials through bank loans and 3% through credit cards, much lower than the 25% and 11% in the US. The utilization rate of crop insurance is 39%, a significant gap compared with 87% in the United States. There is broad space for the popularization and application of basic financial services such as farmer credit and insurance.

2.1.4. Demand for Agricultural Product Traceability

Food safety incidents such as the Sudan red duck egg case have continuously raised public attention to the quality and safety of agricultural products, and "safe consumption" has become a core demand. The state has vigorously promoted the construction of an agricultural product traceability system by establishing the Agricultural Product Quality and Safety Center and revising the Law on Agricultural Product Quality Safety, providing strong policy support for the standardized development of the industry.

2.1.5. Technology Application

Blockchain and smart contract technologies have begun to be applied in agriculture, but the overall application remains at the stage of pilot projects and scattered deployment. A linkage mechanism between agricultural financing and agricultural product traceability has not yet been established, the core value of technology has not been fully released, and data, services and scenarios have not been effectively integrated.

2.1.6. Demand for Bank Agriculture-Related Services

The domestic banking system has carried out a number of explorations and achieved certain breakthroughs in agricultural finance and traceability services, but there are common shortcomings in service accuracy and efficiency matching. Mature and efficient large-scale service models for agriculture-related financing and traceability have not yet taken shape.

2.2. Core Problems

2.2.1. Agricultural Investment and Financing

First, financing rounds are extremely unbalanced: over-concentration in early-stage financing and severe shortage of late-stage financing, breaking the full life-cycle financing chain of enterprises. Second, credible asset data of agriculture-related business entities are insufficient, making it impossible for banks to establish an accurate asset value evaluation system, resulting in a lack of scientific basis for risk judgment and quota determination. Third, the collection of agriculture-related information is costly, time-consuming and poorly dynamic, making it difficult for banks to grasp the real-time status of business entities and restricting the large-scale development of financing business.

2.2.2. Inclusive Financial Services

The penetration rate of basic financial services such as farmer credit, insurance and payment and settlement is extremely low. Financial products are mismatched with farmers' production and operation needs. Inclusive finance lacks sufficient depth and coverage in rural areas, and the availability and utilization rate of farmers' financial services are far lower than those in developed countries.

2.2.3. Agricultural Product Traceability System

First, the mainstream "centralized platform + QR code" model has data falsification risks; information cannot be dynamically updated or verified after initial entry, making authenticity difficult to guarantee. Second, traceability only covers production and sales, lacking data on core intermediate links such as warehousing and logistics, failing to realize full-process closed-loop traceability. Third, there is no unified standard for agriculture-related data collection, leading to both data redundancy and missing key information, reducing the accuracy of traceability services.

2.2.4. Technology Integration and Application

The application of blockchain and smart contracts in agriculture is scattered and fragmented, without forming a "financing-traceability" linkage mechanism. The financing side lacks reliable production data, resulting in low accuracy of microcredit risk assessment. The traceability side is not linked to credit information and cannot provide credible data for financial services. Financing, traceability and circulation data are isolated from each other, so that the core advantages of technology such as tamper-proofing and automatic execution cannot be exerted, making it difficult to achieve cost reduction, efficiency improvement and risk control.

2.2.5. Bank Agricultural Services

Banks lack systematic agriculture-related data service capabilities, failing to support accurate full-process traceability of agricultural products and meet consumers' demand for verifiable and queryable traceability information. Meanwhile, the rigid agriculture-related financial service model and poor demand adaptability restrict banks' value empowerment and brand competitiveness in the digital agricultural ecosystem.

3. Construction of Collaborative Solution

3.1. Theoretical Design

3.1.1. Design of Trusted Data System Based on Blockchain and Sha-256 Algorithm

Supported by the decentralized architecture of blockchain and equipped with the SHA-256 hash algorithm as the core security technology, a trusted collaboration system without endorsement from a single institution is constructed. The SHA-256 algorithm generates a unique and irreversible hash value for each piece of data, ensuring that on-chain information cannot be tampered with at the

technical bottom layer and that data is authentic and traceable. Combined with distributed storage, it realizes the on-chain storage of full-dimensional data covering agricultural financing, production, traceability and circulation, solving problems such as data falsification, low data credibility and information islands in the traditional centralized traceability model, and provides a secure and trusted data foundation for full-scenario agricultural collaboration.

3.1.2. Design of Automated Financing-Traceability Linkage Framework Based on Smart Contracts

Taking blockchain as the carrier, the theoretical design of smart contracts is carried out. Relying on the core advantages of smart contracts such as automatic execution, decentralization, security, transparency, low cost and high efficiency, a business operation logic of "condition preset – automatic trigger – full-process traceability" is established. Smart contracts can automatically execute operations according to preset rules without manual intervention or third-party intermediaries. All terms and records are open, transparent and tamper-proof. While reducing trust and execution costs, it realizes the automatic linkage between financing risk control and traceability verification, forms a closed-loop "financing-traceability" business, and solves problems such as inaccurate credit risk assessment, fragmented processes and limited application scenarios.

3.1.3. Design of Full-Process Data Collection Based on Lightweight Data Acquisition Protocol

A lightweight data acquisition protocol is adopted to design the front-end data access layer, with low power consumption, low bandwidth occupation and high compatibility as core objectives, so as to optimize the adaptability of equipment and networks in agricultural scenarios. By streamlining redundant links in data transmission, efficient data collection, verification and transmission can be achieved in environments with limited computing power and unstable networks. Meanwhile, it is compatible with various types of terminal equipment and communication interfaces, unifies the standards of agriculture-related data collection, addresses pain points such as high cost, long cycle, insufficient dynamics and missing key data in agricultural information collection, and provides a stable and efficient data input channel for back-end technical applications.

3.1.4. Design of Full-Link Data Security System Based on National Cryptographic Algorithms

A hierarchical security protection framework is built using a combination of national cryptographic algorithms SM2, SM3 and SM4, realizing independent and controllable security protection for the whole process of agricultural data. Among them, the SM2 asymmetric encryption algorithm is used for trusted identity verification and data signature; the SM3 hash algorithm ensures data integrity and anti-tampering; the SM4 symmetric encryption algorithm encrypts the storage and transmission of sensitive information. It fully covers security requirements such as identity authentication, data tamper-proofing and privacy protection, providing a core security barrier compliant with national security standards for agricultural financing and agricultural product traceability services.

3.2. Practical Operation

Multi-dimensional data including equipment traceability, enterprise operation, and subsidy/loan performance are integrated via blockchain to form full-link data assets of agricultural entities covering "production — operation — credit". Smart contracts are then embedded to ensure information authenticity at the traceability end to enhance consumer trust, and automatically trigger credit processes at the financing end to solve financing difficulties for agricultural entities. Finally, a positive cycle of "traceability strengthens credit→financing is implemented conveniently→funds feed back traceability optimization"is formed, realizing the in-depth integration and two-way empowerment of financing and traceability at the data, mechanism and value levels.

3.2.1. Application Trigger Conditions

After an enterprise completes the use of government subsidies and special equipment loans (i.e., equipment purchase is verified on the platform chain), the platform automatically opens the application entrance for agricultural production and operation loans. Enterprises can also initiate applications voluntarily before key nodes of the production cycle. Smart contracts automatically verify two core conditions: The enterprise has no bad credit record on the platform;No abnormal interruption of on-chain production data from platform-certified IoT devices in the recent 6 months.

Enterprises do not need to resubmit basic qualifications archived on the platform. They only need to upload three types of materials to apply for agricultural production and operation loans:Subsidy/loan performance data;Equipment traceability data;Semi-annual enterprise operation data.

The materials are processed by the platform's encryption algorithm to generate a unique verification code, and viewing permissions are only open to core approvers.

3.2.2. Data Integration and Credit Indicator Calculation

Enterprises are required to submit three types of core data for credit evaluation: equipment traceability data, semi-annual operation data, and subsidy/loan performance data. Among them, equipment traceability data, as the core of "production credibility"in agricultural scenarios, accounts for 40%; operation and performance data each account for 30%. Credit indicators are calculated as:

Credit Score = Equipment Traceability Data × 40% + Operation Data × 30% + Performance Data × 30% (with a full score of 100)

Relevant indicators are synchronized to the risk control system and the enterprise terminal in real time. Data weights and calculation logic are disclosed to all nodes to ensure transparent evaluation.

As enterprise operation and credit performance change dynamically, the credit rating is not fixed by a single calculation. It is recalculated and adjusted semi-annually based on the model to reflect the actual credit level in real time and encourage enterprises to maintain sound credit behavior. Finally, enterprises are divided into three credit grades according to their scores, with corresponding financing quotas and permissions matched.

Table 1. *Credit Rating*

80≤Score≤100	Grade A	Eligible for agricultural production and operation loans with higher credit limits and preferential interest rates.
60≤Score<80	Grade B	Eligible for agricultural production and operation loans with basic credit limits at benchmark interest rates.
0≤Score<60	Grade C	Suspended from applying for agricultural production and operation loans. Reapplication is allowed only after credit restoration.

3.3. Automatic Execution by Smart Contracts

3.3.1. Financing Approval Contract

After an enterprise submits an agricultural production and operation loan application and the platform completes the credit indicator calculation, the score is synchronized to the contract to trigger approval.Grade A enterprises: Automatic loan approval. Quota = Basic 500,000 yuan × Score / 80, with a preferential interest rate of 4.2%, term 1–3 years, quarterly repayment.Grade B enterprises: Automatic loan approval. Quota = Basic 300,000 yuan × Score / 60, with a benchmark interest rate of 4.8%, term 1–2 years, monthly repayment.

The contract automatically generates a loan agreement including quota, interest rate, repayment schedule and subsidy information, which is recorded on the chain and sent to the enterprise. Loan will be disbursed within 1–3 working days after confirmation, with the whole process recorded on the chain for supervision and traceability.

3.3.2. Traceability Incentive Contract

Positive incentives are triggered if an enterprise completes IoT equipment addition/upgrading with a month-on-month increase of ≥10% in monthly traceability data integrity, or Grade A/B enterprises repay in compliance for 2 consecutive quarters and 6 consecutive months respectively. Reverse constraints are triggered if equipment data is interrupted for more than 7 days, equipment special loan is overdue for more than 1 day, or subsidies are misappropriated.In positive incentives:

Data improvement ≥10%: credit score +5 points, loan ceiling +20%, interest rate-0.3% for next loan.Long-term compliant repayment: credit score +3 points and extended loan term.

Reverse constraints are divided into minor and serious violations, with credit score reduced by 8

points and 20 points respectively, together with measures such as suspending quota increase, freezing special loans, suspending or cancelling subsidy eligibility.The contract automatically generates incentive notices and sends them to enterprises, banks and government regulators. Status will be updated and rights restored in real time after rectification, with results publicized.

3.3.3. Risk Early Warning Contract

The platform monitors four types of risk signals in real time: equipment, subsidies, special equipment loans and agricultural production and operation loans. Early warning is activated once triggered.

Level 1 (Minor): Push rectification notice and follow-up by customer manager. No restriction on loan and subsidy use if enterprise submits rectification commitment.

Level 2 (Moderate): Freeze 50% of unused loan quota, suspend subsidy disbursement, require rectification within 7 days. 30% quota unfrozen and subsidies resumed after approval.

Level 3 (Severe): Freeze all loan quotas, terminate contracts in advance, recover full subsidies, pursue legal recovery, permanently cancel subsidy eligibility. Risk records are synchronized to banks, government and central bank credit system, restricting financial services and policy support.

Warnings of different levels are pushed to relevant parties in real time with risk details. After warning release, status is updated automatically and a risk release certificate is issued for the enterprise.

4. 4. Expected Benefits and Risk Responses

4.1. Expected Benefits

4.1.1. Economic Benefits

The platform effectively reduces the comprehensive operating costs of agricultural enterprises, optimizes financing processes, improves capital efficiency, and enhances the market value of agricultural products and enterprise revenue through credible traceability. For banks, standardized evaluation and automated processes reduce operational and credit risks and expand agriculture-related business. It also improves the efficiency of fiscal subsidy use and guides more financial resources into agriculture.

4.1.2. Social Benefits

It promotes digital and standardized transformation of agricultural production, helps build a high-quality and favorable-price market system, stabilizes the agricultural supply chain, and increases rural employment and farmers' income. Blockchain-based full-process traceability significantly improves food safety, strengthens producer responsibility and protects consumers' rights.

4.1.3 Ecological Benefits

With a "green data compliance → financing interest discount" mechanism, the platform guides agricultural enterprises to reduce pesticides, fertilizers and energy consumption, driving the shift to green and low-carbon agriculture. It supports the government in building a closed-loop supervision system for green production and can connect to the carbon trading market to realize agricultural carbon sink value, promoting sustainable agricultural development.

4.2. Risk Responses

First, technical risks: weak network in remote areas may cause IoT data loss; inconsistent platform architecture and interfaces lead to data delay; low information security awareness of employees brings risks of information leakage and data fraud. Responses: encrypt sensitive data with zero-knowledge proof, adopt hierarchical blockchain node permissions; develop offline caching and lightweight tools for IoT devices; build provincial and municipal dual-backup data centers to ensure data security and system stability.

Second, business operation risks: SMEs may falsify data to increase credit risk; delayed subsidy disbursement hinders production; extreme weather reduces repayment capacity. Responses: embed multi-dimensional cross-verification in smart contracts, establish reporting and reward-punishment mechanisms; cooperate with governments to clarify subsidy rules and set up standby fund pools for interest-free advances; launch "credit & insurance" products with insurers to mitigate risks.

Third, ecological collaboration risks: equipment suppliers lack trust and require full payment, increasing financial pressure; consumers doubt traceability data with imperfect feedback channels. Responses: launch industrial chain collaboration incentive plans, support installment suppliers and publicize honest enterprises; optimize one-click traceability feedback and set up a cross-subject mediation committee to enhance market trust.

5. Conclusion

Focusing on the dual dilemmas of financing and traceability in the agricultural supply chain, this study constructs a collaborative solution empowered by blockchain and smart contracts, designs practical operations, and analyzes benefits and risks. The core conclusion is: blockchain's tamper-proof and distributed storage features, together with the automatic execution capability of smart contracts, provide key technical support to solve information asymmetry, low efficiency and high risk control difficulties in the agricultural supply chain. Their integration realizes two-way empowerment of financing and traceability, forming a service system with credible data, intelligent processes and controllable risks.

The dynamic credit evaluation system based on multi-dimensional data effectively converts production and traceability data into financing credit assets, breaking the collateral barrier of traditional agriculture-related financing. The automatic execution of smart contracts simplifies banks' credit processes, reduces risk control costs, and forces agricultural entities to standardize operations through traceability incentives and risk early warnings, improving the integrity and credibility of agricultural product traceability.

The collaborative platform constructed not only provides a practical path for banks to expand inclusive agriculture-related finance and direct financial resources more accurately to agriculture, but also promotes the digital and standardized transformation of the agricultural supply chain and the formation of a high-quality and favorable-price market system. Meanwhile, it drives green and low-carbon agricultural development through green financial incentives, achieving the unity of economic, social and ecological benefits.

In the future, the platform can be connected with the agricultural carbon trading market and the national agriculture-related credit system. The multi-agent collaboration mechanism can be optimized, the credit evaluation model and smart contract rules can be continuously iterated to adapt to diverse agricultural needs, providing sustainable and efficient financial and technical support for rural revitalization and agricultural modernization.

References

Liu R Y, Li J B, Li X D. Application modes and implementation of blockchain in agricultural product circulation [J]. China Business and Market, 2020, 34(03):43-54. DOI:10.14089/j.cnki.cn11-3664/f.2020.03.006.

Li G C, Li Q N, Ye F, et al. Research on the impact of digital rural development on the growth of agricultural tot al factor productivity: From the perspective of scale operation and industrial agglomeration[J/OL]. Researc h of Agricultural Modernization, 1-15 [2026-02-12]. https://doi.org/10.13872/j.1000-0275.2025.1226.

Tan F, Liu Y, Liu X C. Development of digital finance and modernization of agricultural industrial and supply c hains[J]. Journal of Technoeconomics & Management Research, 2025,(12):78-84.

Li M Q, Guo P, Ke X L. Two-way dilemmas and their solving mechanisms of agricultural supply chain financin g models from the perspective of new institutional economics theory: A case study of citrus supply chain in Kecheng District, Quzhou City, Zhejiang Province[J]. Acta Agriculturae Zhejiangensis, 2023, 35(08):1937 -1949.

Liu Q Y, Chen J, Zhang C K. Research on innovative paths of agricultural supply chain financing empowered by digital intelligence[J]. Communication of Finance and Accounting, 2024,(16):139-143. DOI:10.16144/j.cn ki.issn1002-8072.2024.16.019.

Ke H S. Research on innovative models of agricultural supply chain financing[J]. Agricultural Economy, 2023, (02):136-137.

Sun T Q, Deng H, Tian Y Q. Origin, operational logic and evolutionary prospect of China's policy-oriented agric ultural credit guarantee system[J]. Chinese Rural Economy, 2024,(09):63-79. DOI:10.20077/j.cnki.11-126 2/f.2024.09.004.

Yang X T, Li R, Li J H, et al. Research progress of agricultural food traceability based on blockchain technology [J]. Food Science, 2024, 45(20):20299-20310.

Yang X H, Wang J. Theoretical origin and connotation analysis of modern agriculture: Also on the development approaches of modern agriculture in China[J]. Review of Economic Research, 2017,(16):69-75. DOI:10.16110/j.cnki.issn2095-3151.2017.16.011.

Wu X Q, Yang J H. Research on digital rural construction from the perspective of policy tools: A content analysis based on Digital Rural Development Action Plan (2022-2025)[J]. Journal of Tangdu, 2024, 40(04):28-36.

Yang B H, Shen W X, Tang Z Z, et al. Research on the usage intention of agricultural product traceability system: An empirical study based on PLS-SEM[J]. Chinese and Foreign Food Industry, 2025,(01):99-101.

Wang X P, Wei Z Q. Research progress and prospect of agricultural product traceability[J]. Jiangsu Agricultural Sciences, 2024, 52(18):1-9.

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