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Functional Agricultural Product Safety Traceability System Based on Blockchain Technology

Yao Li[1,2*]

[1]*Zhanjiang Science and Technology College, Zhanjiang, China*

[2]*Assumption University, Bangkok, Thailand*

yaoli@zjkju.edu.cn

[*]*corresponding author*

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Abstract: With the emergence and widespread application of intelligent technologies such as the Internet of Things and big data, many researchers have also begun to combine emerging technologies with agricultural product traceability systems. These studies have made innovations in the platform or technology of data query and reading. However, in the traditional agricultural product traceability system, the problems of data management, such as scattered information, difficulty in sharing, and difficulty in traceability, still exist. The purpose of this article is to study the functional agricultural product safety traceability system based on blockchain technology. This article first analyzes the purpose and mode of product tracing. In view of the high cost and low tracing efficiency of traditional tracing mode, this paper improves the traditional tracing mode based on the theoretical basis of blockchain technology and proposes a reverse search and recursive algorithm a tracing scheme formed by the combination of ideas. Finally, this paper designs and implements the agricultural product safety traceability system. The experimental results show that the scheme proposed in this paper is more efficient than traditional traceability models. And by testing the performance of the system, the test results show that the system can meet the demand. In this paper, through testing the traceability rate of different schemes, the traceability rate of the scheme proposed in this paper is stable at about 1000 milliseconds.

1. Introduction

In the impact of the rapid development of the global economy, people's lifestyles have been changed, people's living standards have been continuously improved, and consumers' demand for green and non-polluting agricultural products is constantly increasing. Those who pay more attention to the safety of agricultural products. However, in recent years, there have been reports of agricultural product safety or food safety issues in news reports, which has caused consumers panic.

Although there are many current food traceability methods, the efficiency of implementation is not high, it cannot be widely used, and the effect is not very satisfactory. At present, the commonly used centralized traceability methods also have many drawbacks.For example, information cannot be shared between enterprises, less traceable information, opaque data, data is easily tampered with in the hands of core companies, and the traceability methods of various companies also lack uniformity management and planning. Based on the problems of the above food traceability methods, this paper proposes a blockchain-based food traceability method. Because blockchain technology has the advantages of decentralization, distributed storage, openness and transparency, and non-tampering, blockchain technology is applied to the traceability of agricultural products will effectively solve the problems of the current centralized traceability methods.

David Yermack believes that blockchain represents a novel application of the old problems of encryption technology and information technology in the retention of financial records, which may lead to profound changes in corporate governance. He assessed the potential impact of these changes on managers, institutional investors, minority shareholders, auditors and other parties involved in corporate governance. The lower cost, greater liquidity, more accurate record keeping, and transparency of ownership provided by the blockchain may greatly disrupt the balance of power among these groups [1]. Hu Y believes that the relevant information is used to mark the quality and safety of agricultural products at each stage, which is an important means of determining the supervision and management responsibility of agricultural products from production to market. Establishing a system to track the quality and safety of agricultural products is of great significance to ensure food safety from farmland to table and promote the modernization of agriculture in the country. He highlighted four main goals and three policy recommendations for the future development of China's agricultural product quality and safety traceability system [2]. Wen-Hwa Ko's team believes that food safety is a global public health problem, usually caused by information asymmetry between consumers and suppliers. With the development of information technology in human life, establishing a food traceability information sharing platform is regarded as one of the best ways to overcome the crisis of trust and solve the problem of information asymmetry in China [3].

This paper aims at the problems of high cost and low efficiency of traditional traceability mode, combined with the theoretical basis of blockchain technology, this paper proposes a traceability scheme formed by the combination of reverse search and recursive algorithm. This paper also designs and implements the agricultural product safety traceability system. The experimental results show that the scheme proposed in this paper is more efficient than traditional traceability models. And by testing the performance of the system, the test results show that the system can meet the demand.

2. Proposed Method

2.1. Traceability Technology

(1) Product traceability

The product quality traceability platform is to record the information of the whole process of the product supply chain, and store the product information in the system according to the successive links to ensure the integrity of the traceability information, which helps the production company to control the information of the entire process of the product life cycle. It can track the whole process of products from production to sales in a timely, efficient and error-free manner [4-5].

(2) The purpose of retrospective

The purpose of product quality traceability is quality control, so its core is product data information [6-7]. In general, the data in the traceability system has the following requirements: 1)Standardization: the data and operations of each process are corresponding, and the data format is set according to the standardization requirements of each link, such as the production and processing standards in the production and processing link , product testing standards, logistics links logistics standards, for non-standardized data storage should be found and prevented in a timely manner, at the same time report to the relevant agencies to prevent potential risks. 2) Correctness, validity and timeliness: the product information must be correct, it is necessary to develop relevant mechanisms and use digital management tools to ensure the accuracy of data collection and reduce data errors caused by human factors; the data must be valid to ensure the authenticity of product information data; the data must be timely, and the information of the product in one link needs to be stored in the system in time, and the data cannot be supplemented in the next link to prevent damage to the authenticity of the data. 3) Data relevance: there must be a certain connection between the data of each process, and the product information of the production process, transportation process, and sales process can be linked through the product traceability source code, or there is certain data between the two adjacent links correlation, to ensure data integrity and reliability throughout the product supply chain [8-9].

(3) Retrospective mode

There are various product quality traceability modes. The following mainly introduces the chain traceability mode.

The chain trace mode is to trace the source of each link of the product circulation one by one when the product has quality and safety problems, that is, when the trace retroactive, no matter where the product has a problem, trace the product information of each process. In this way, to determine the specific link and cause of the problem [10-11].

The chain tracing model can satisfy the product information tracing and clarify the problematic links, but also has some shortcomings: the chain tracing will trace the entire process of product circulation every time trace retroactive, even if it appears in the sales link for problems, it is also necessary to trace the previous production, processing and logistics links, and the cost of traceability is high; chain traceability needs to trace all the links before the problem link, so the traceability period is long and the query speed is slow.If a link appears failure, it will stop retrospective, poor stability [12-13].

2.2. Blockchain

(1) Blockchain

Blockchain storage is a kind of chain storage.The generated transaction information is stored in blocks.Each block contains a timestamp. Blocks are linked back and forth according to the chronological order of generation. Blocks are linked based on construction of hash value of block storage content [14-15].

After the block is generated, it will be synchronized in each node (individual or organization) of the blockchain system, so each node finally saves a complete and consistent data [16-17]. In other words, the blockchain system will maintain the final consistency, but does not guarantee real-time consistency. From a structural point of view, a blockchain is a chain of blocks composed of all exchanges in different time periods in chronological order. Each block should contain at least the following information: the unique identifier of the block, the unique identifier of the previous block, the block header, transaction data, random numbers.

(2) Blockchain technology

1) Asymmetric encryption algorithm

The data encryption process of the asymmetric encryption algorithm is: the sender user 1 uses the public key of the receiver user 2 to encrypt the information to be sent, and after receiving the cipher text, user 2 decrypts the information with its own private key to obtain the plain text.This process guarantees the security of data transmission. The function of the communication process is expressed as:

$$Enc(Key_1, P) = C \tag{1}$$

$$Enc(Key_2, C) = P \tag{2}$$

Among them, *Enc* represents the encryption algorithm, *Dec* is the decryption algorithm, Key_1 is the encryption key, Key_2 is the decryption key, *P* is the plaintext information that needs to be transmitted, and *C* is the ciphertext obtained after the plaintext encryption. The process of data signing and verification of the asymmetric encryption algorithm is: the sender user 1 signs the information to be sent with his own private key, and the receiver user 2 receives the information sent by user 1 to verify the signature with user 1's public key. The process of signing and verifying data using asymmetric encryption algorithms can prove the identity of both parties to the transaction and ensure the correctness and security of information transmission.

2) Consensus algorithm

Proof of Work (PoW) algorithm is to ensure the data consistency of all nodes by participating in the competition of the computing power of each node of the system [18-19]. In the bitcoin system, nodes use their own computing power to solve a SHA256 mathematical problem.This answer is easier to verify but the calculation process is very complicated.The node that gets the answer first gets the right to record the data on the block, and gets a certain amount of bitcoin. The difficulty of generating blocks can be expressed by formula (3):

$$D = \frac{T_I}{C_t} \tag{3}$$

Among them, T_I represents the difficulty target, C_t represents the current difficulty target, and D represents the difficulty of generating blocks. This kind of proof-of-work consensus algorithm can ensure data consistency and security, but it will consume huge power and computing resources.

Proof of Stake is an improved consensus algorithm that can solve the problem of waste of power and computing resources in PoW. The difficulty of generating block of proof of stake algorithm can be expressed by formula (4):

$$H(B,t) \leq Bal * T \tag{4}$$

Among them, *Bal* represents the number of nodes' tokens, *T* represents the difficulty target, and *H* represents the difficulty of block generation. This formula indicates that the node with the largest stake in the system is most likely to obtain the right to record and generate blocks. In the proof-of-stake algorithm, the participants with the highest rights in the network have the right to obtain the recorded data of the block. Proof of stake algorithm improves the efficiency of consensus, greatly shortens the time of generating blocks, and increases the number of transactions per second in the system.

3) Smart contract

Smart contract is a computer program that can process data actively or passively and is the core technology of blockchain. After being signed by each node in the system, the smart contract is attached to the blockchain in the form of a program and transmitted to other nodes in the system through the P2P network.After the node is verified, the smart contract is recorded in a specific block of the blockchain[20-21]. The smart contract encapsulates many previously set programs. When a certain trigger condition is met, the program will be activated and the program will be executed.Once the smart contract runs, it will not be interfered by other nodes in the system. Smart contracts need to run in an isolated environment, so as to avoid loopholes in the smart contract program or virus code threatening the operation of the entire blockchain system.

2.3. Blockchain-Based Agricultural Product Safety Traceability System

(1) Traceability scheme based on reverse sequence stitching

In the environment of agricultural product supply chain, after the system completes the traceability, it is necessary to stitch the matching information from the blockchain to form the current traceability information [22-23]. However, according to observations and research, it is necessary to repeatedly combine the previous traceability information in each traceability process, and the new step is only to add the latest one after the information chain [24-25]. According to this characteristic, this paper proposes a new solution for the traceability system of agricultural products supply chain based on blockchain-option 1: the stitching-based traceability scheme is used to solve the existing traceability speed in the existing technology. The technical problem of increasing the information in the blockchain and greatly decreasing it. Compared with the original system, the system structure of scheme 1 adds information interaction between the traceability module and the on-chain module of its back-end service.The interaction of this information means that when the information is on-chain, the on-chain module will call the traceability module to the blockchain[26-27]. Search the data in and return the search results. Moreover, the first scheme divides the on-chain module into two sub-modules: source of rev and receipt. They are used to respond to the source request and receipt request sent by the function selection module. The structural diagram of the traceability system module of scheme one is shown in Figure 1.

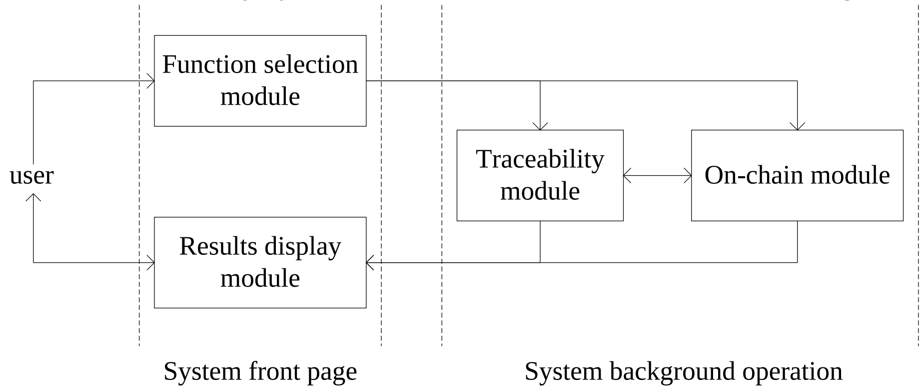

Figure 1. Structure diagram of the traceability system module of scheme one

It is roughly divided into three main processes, the source information on-chain process, the receipt information on-chain process and the traceability process.

1) Source information on-chain process

The user selects the start source function of the function selection module and enters the source information: first, the farm user selects the start source function in the function selection module and fills in the source information of the agricultural product name, agricultural product batch and farm address, and the function selection module sends the source information to source of rev sub-module;

The source of rev sub-module generates an agricultural product ID number: source of rev of the on-chain module receives this source of rev request and generates the agricultural product ID number of this agricultural product according to the source of rev request information and the current timestamp.The agricultural product ID generation formula is:

$$productId = SHA(farmAddress + proName + proBatch + proDate) \tag{5}$$

Among them, $productId$ represents the ID number of the currently generated agricultural product, $productId$ represents the hash 256 function, $farmAddress$ represents the farm address, $proName$ represents the name of the agricultural product, $proBatch$ represents the production batch of agricultural products, and FF represents the time stamp of the production time;

The source of rev sub-module generates a two-dimensional code for agricultural products: The source of rev sub-module encodes the two-dimensional code of the agricultural product ID to obtain the agricultural product two-dimensional code.

$$QR\_Pic = QR\_ENcode(productId) \tag{6}$$

Among them, QR_Pic represents the QR code picture of agricultural products, and QR_Pic represents the QR code encoding function;

The source of rev sub-module generates source-chain information and links it to the information: the source of rev sub-module connects the agricultural product number, agricultural product name, agricultural product batch, production time, and farm address with the “;” as an interrupt to form the source chain Information, and upload it to the chain, and finally return the result of the chain to the result display module, and its generation formula is as follows:

$$\begin{aligned} &sourceData + productId + ";" + timestamp + "/" + native2ascii(farmAddress) \\ &+ "/" + native2ascii(productName) + "/" + productBatch \end{aligned} \tag{7}$$

Among them, it refers to the information on the source chain, which is an interruption character, which is convenient for truncating and extracting the information during traceback, a separator for the timestamp and address information, and a method for converting local code to ASCII encoding to prevent interruption. Character or affect the extraction of information during traceability;

The result display module displays the above result.

2) Receiving information on-chain process

The user selects the receipt function of the function selection module and scans the QR code: the farm user selects the receipt function in the function selection module, and the system will pop up the front-end interface for scanning the QR code. Code information, the agricultural product number information is obtained at this time, and then the agricultural product number information is handed over to the receiving submodule by the function selection module;

The receipt submodule calls the traceability module to obtain the previous traceability information, and generates the receipt information, and then uploads the information to the chain, and then sends the chaining result to the result display module: the receipt submodule transmits the agricultural product number to the traceability module, the traceability module searches the blockchain information and returns all the traceability information matching the lock, and then the receiving submodule appends the user's address and current time stamp to this traceability information to form the latest traceability information. Then, the receiving sub-module will upload the traceability information to the chain, and then send the results of the chain to the result display module.

The new traceability information generation formula is as follows:

$$\begin{aligned} &receiptData = productId + ";" + getTraceInfo(qrInfo) + "-" + timestamp + "/" \\ &+ native2ascii(userAddress) \end{aligned} \tag{8}$$

Among them, *receiptData* represents the newly generated receipt information, $getTraceInfo(\cdot)$ represents the tracing function of the tracing module, the input parameter is the agricultural product QR code information *qrInfo*, "-" is the separator between the tracing information, so that the tracing information will be convenient for subsequent tracing segmentation;

The result display module displays the results of the chain.

3) Traceability process

The user selects the traceability function in the function selection module and scans the QR code: The user selects the traceability function in the function selection module and scans the QR code to obtain the agricultural product ID information in the QR code and then sends this information to backtracking module;

The traceability module searches the blockchain and returns the results;

The result display module displays the retrospective results.

(2) Traceability scheme based on reverse order recursion

Although the above scheme 1 solves the problem that the traceability rate of the existing blockchain-based agricultural product supply chain traceability scheme will be greatly reduced as the system capacity increases, at the same time, you can also understand this the scheme will cause a waste of space resources, and as the system capacity increases, this waste will become more and more serious. It can therefore be concluded that scheme one sacrifices a lot of space complexity while obtaining a lower time complexity. In order to solve this problem, this paper combines the research of data structure and algorithm on the basis of the first scheme, and proposes a second solution here-the second scheme: the recursive-based traceback scheme. The source information on-chain process in its three main processes is basically the same as scheme 1. The operation schematic diagram of the system on-chain and traceback process of scheme two is shown in Figure 2.

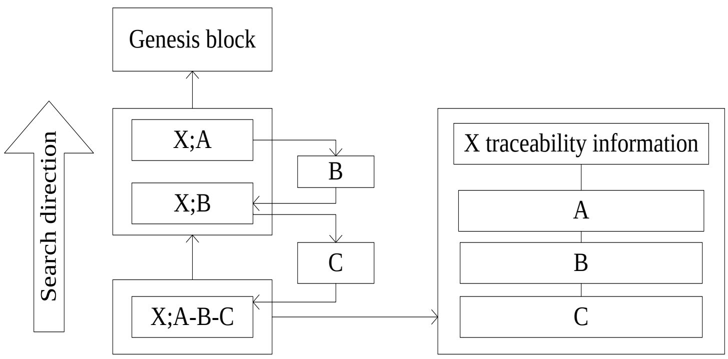

Figure 2. Schematic diagram of the operation of the system on the chain and the traceback process of scheme two

1) Receiving information on-chain process

The user selects the receipt function of the function selection module and scans the QR code: here is consistent with the plan one.

The receipt submodule calls the traceability module to obtain the previous traceability information, and generates the receipt information, and then uploads the information to the chain, and then sends the chaining result to the result display module. The difference here is that the receiving sub-module transmits the agricultural product number to the traceability module.At this time, in addition to obtaining all traceability information from the traceability module (only for user confirmation information, no longer on the chain), it will also obtain the latest The transaction address of the information on the chain, and then attach the agricultural product number, current time stamp and user address after the transaction address. The receipt information generation formula is as follows:

$$receiptData = productId + ";" + getLatestAddress(productId) + ";" \\ + timestamp + "/" + native2ascii(userAddress) \tag{9}$$

Among them, $getLatestAddress(\cdot)$ represents the function of the traceability module to obtain the latest transaction address of the current agricultural product,

The incoming parameter is the agricultural product number.In order to save space complexity, the transaction address here uses the exchange stitching transaction offset in the block number of the exchange to replace the hash address of the transaction, where the transaction offset refers to the transaction in the area The subscript value of the transaction array in the block, for example, the transaction address indicates the transaction with the subscript 12 in block 102, where ";" is the delimiter;

The result display module displays the results of the chain.

2) Traceability process

The user selects the traceability function in the function selection module and scans the QR code: here is consistent with the scheme;

The traceability module searches the blockchain and returns the result: As shown in Figure 2, the difference between this and Scheme 1 is that when the system searches for the first traceability information matched by the blockchain from near to far, the only information obtained is The traceability information of agricultural products in a single link is not complete traceability information, so it is necessary to use the previous transaction address that was previously deposited in the receipt process to perform a recursive algorithm until the recursion to a link address is for the agricultural Circulation information, at this time, return to the information layer by layer to obtain the complete traceability information as the traceability result, and finally the traceability module returns the traceability result to the result display module[28-29].

$$recursion(address\_now) = recursion(address\_prev) + "-" + \\ toDate(timestamp) + "/" + ascii2native(userAddress) \tag{10}$$

Among them, $recursion(\cdot)$ represents the recursive algorithm, the incoming parameter is the address of the transaction, $address\_now$ represents the address of the current transaction, $address\_prev$ represents the address of the previous transaction, $toDate(\cdot)$ represents the function of converting the time stamp to the normal time format, and $ascii2native(\cdot)$ represents the conversion of the ASCLL code into Locally coded function; result display module displays traceability results.

3. Experiments

3.1. Data Collection

The experiment will use Geth simulation to build three blockchains for experimental comparison.The difficulty of block generation is set to 0x200.The simulated transaction data is gradually added to the blockchain until 9800, and the experimental data is recorded every 200. Because the search scope of scheme 1 and scheme 2 is related to the location of the latest matching data on the blockchain, considering that the traceability system is applied to agricultural products with a short shelf life, the last transaction of the same agricultural product in the simulation data is set to the distance There are currently about 200 transactions, and the total number of links in the supply chain of the same agricultural product does not exceed 10. Finally, considering that the result of the experiment is to record the running time of the program, which has a certain randomness, so the average data of 20 experiments is taken for each record.

3.2. Experimental Environment

Ethereum provides people with a very rich API and development client, and provides support for various high-level programming languages, including go language, C++, Java, Python, where the development client based on go language Geth is its the one with the most current maintenance efforts. Considering the stability and security of the development, the paper decided to use Geth as the development client of the blockchain. The system development environment of this article is shown in Table 1.

Table 1. System development environment

Development environment	Parameter
Blockchain development client	Geth
Blockchain development kit	Web3
Auxiliary database	MySQL
System framework	Express
Operating system	Windows10
CPU	Core i7
RAM	8G
Hard disk	250G

3.3. System Architecture

The system is mainly divided into three structural layers, namely display layer, business logic layer and network & data layer. The display layer mainly includes the function selection page, login / registration page, traceback page and chain page. Among them, the function selection page can provide users with corresponding function options according to different information rights of users; the login / registration page provides users with login / registration services; the traceback page provides users with traceability of agricultural products; the on-chain page includes two subpages , sub-page 1 that provides the source information release function of agricultural products, and sub-page 2 that provides the confirmation receipt information release.

The business logic layer mainly includes userRoute which provides user management function, traceRoute which provides traceability function of agricultural products, and insertRoute which provides data chaining function.

The network layer & data layer mainly include MySQL, which provides access to the transaction address information of agricultural products on the blockchain, and the Ethereum blockchain network, which provides storage and search of agricultural product transaction data.

After the above-mentioned logical layering of the agricultural product supply chain traceability system based on blockchain, for users, they only need to care about the display and operation options on the display layer and the returned results of operations.For developers, their subsequent development is also the main focus is on the business logic processing and page jump settings in the business logic layer, so that the entire business process will become very clear, and the system structure is also very clear, which is convenient for future function expansion. The system architecture is shown in Figure 3.

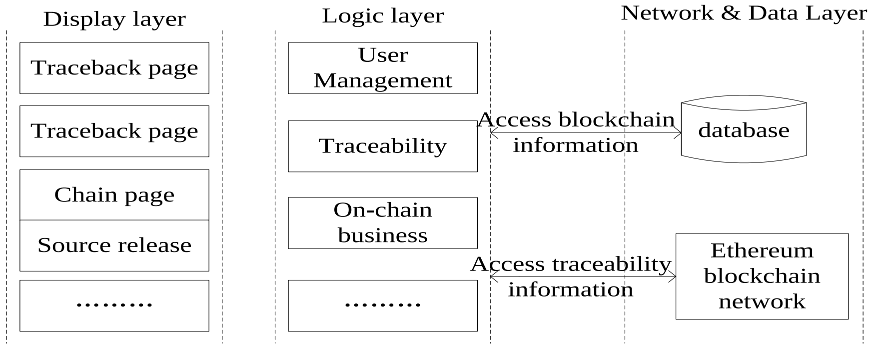

Figure 3. System architecture

4. Discussion

4.1. Analysis of the Comparison Results of the Traceability of Different Schemes and the Space Occupied by the Blockchain

(1) Analysis of comparison results of retrospective rate

The traceback rate is very convenient to measure on the local node, because the functions that perform these operations are usually expressed in code. The retroactive processing time is equal to the time required to update the status database. The comparison results of the traceback rates are shown in Table 2 and Figure 4.

Table 2. Comparison results of traceability

Trading node	200	1800	3400	5000	6600	8200	9800
Existing retrospective model	2000	5000	6000	10000	12000	17000	20000
Plan 1	1050	1100	2000	1000	900	1000	950
Plan 2	1020	1050	1500	980	900	950	930

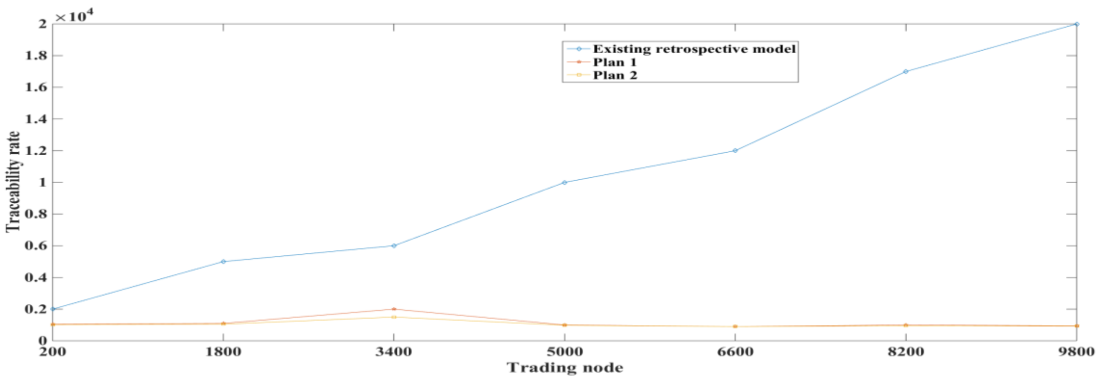

Figure 4. Comparison of traceability results

From the comparison diagram of the trace rate of each scheme in Figure 4, it can be clearly observed that with the increase of transactions in the blockchain in the existing scheme, the time taken for traceability also increases significantly, so the traceability rate decreases. On the other hand, the time spent by both of scheme 1 and scheme 2 is basically stable around 1000 milliseconds, but the time consumption curve of scheme 2 in the figure is basically above scheme 1. That is because scheme 2 does not trace back to the latest results. It can directly return the result like the first scheme, during which it also has a recursive process.

(2) Analysis of the comparison results of the space occupied by different schemes

Modern blockchains use key-value databases, which constantly store hot data in their memory. Any loaded services will be affected by memory leaks caused by errors or attacks against node code. If the memory consumption is increasing or increasing sharply, it is probably caused by a large number of state database keys, large transaction queues, or increased message volume between different node subsystems. The comparison results of the space occupied by different schemes are shown in Table 3 and Figure 5.

Table 3. Comparison results of space occupied by different schemes

	200	1800	3400	5000	6600	8200	9800
Existing retrospective model	0	15000	30000	50000	80000	170000	200000
Plan 1	0	10000	24500	29900	39000	49000	50000
Plan 2	0	10050	25000	30000	40000	50000	50500

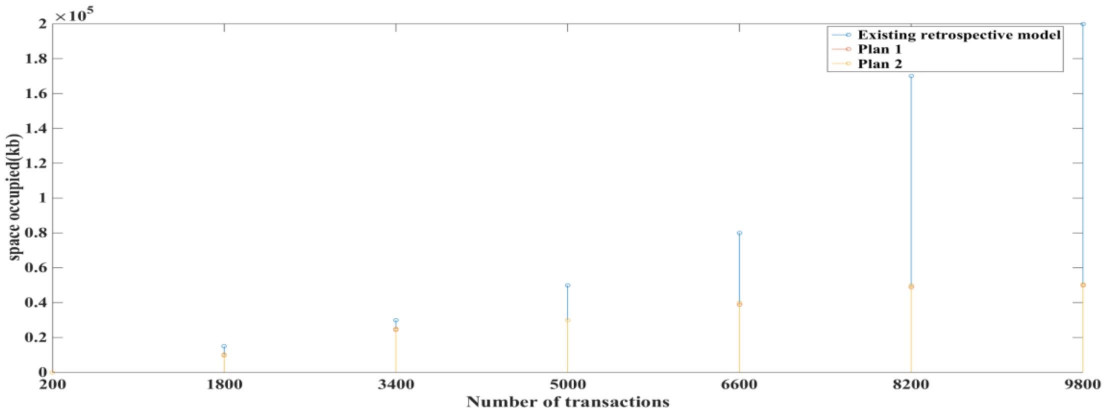

Figure 5. Comparison results of the space occupied by different schemes

From the comparison diagram of the space occupied by the blockchains in each scheme in Figure 5, the existing scheme and scheme 2 have grown steadily and are almost consistent.The total occupied space of scheme 2 in the figure is slightly larger because the scheme 2's uplink data ratio Existing solutions have more addresses than the last transaction, and increase the encoding, but this data volume is very small, relative to the large space occupied by the later period can be ignored. For scheme 1, the size of the space occupied by its blockchain in the figure has grown rapidly compared to the existing technical scheme and scheme 2, and the space utilization rate is very low.It is due to the duplication of its on-chain information. With the increase of transactions in China, the more information that needs to be spliced, naturally a lot of space is wasted.

4.2. Comparison of Uplink Speed and Analysis of System Performance Test Results

(1) Analysis of the comparison results of the chain speed of different schemes

Because there are many hash operations and various information transmission processes in the blockchain's on-chain process, when the on-chain data is getting larger and larger, the on-chain time will naturally increase, when the number of transactions in the blockchain is increased At this time, agricultural products have passed through many links in the supply chain, and at this time, the on-chain data of scheme 1 will include all the previous links, and the on-chain data will naturally be very large, so it has caused its on-chain time to increase with the blockchain. The increase in the number of transaction data in China. The comparison results of the different chain speeds are shown in Figure 6.

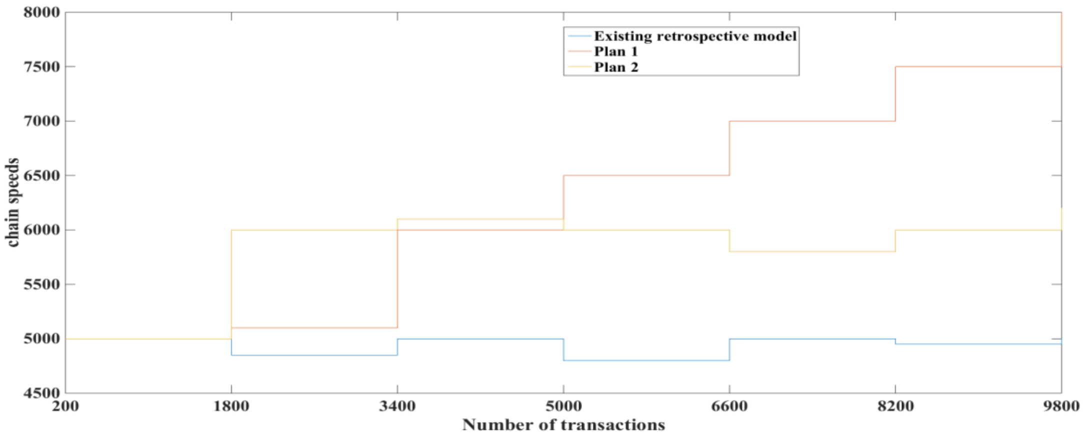

Figure 6. Comparison results of different chain speeds

From the comparison diagram of the uplink speed of each scheme in Figure 6, the winding time of the existing scheme and scheme 2 is almost stable, but the time loss of scheme 2 in the figure is higher than the existing scheme, because scheme 2 is more than the existing scheme there are more traceability module calls in the on-chain process. On the other hand, in the diagram, the first scheme also has a call to the traceability module during the chain process.When the transaction data in the blockchain is less, it is almost the same as the second scheme, but as the transaction data in the blockchain increases, its The time for winding up has gradually increased.

(2) System performance test

This paper uses LoadRunner to test the performance of the system. By creating virtual users, the system performance is monitored in real time in a high concurrency and real load environment. Analyze and test the report to discover the system performance problem in time and optimize the system performance. The following tests the system. Create a virtual user script open the LoadRunner virtual user generator to create an automatic performance test script, enter the value of URLAddress into the address of the system, divide the action during the recording process, and put different operations in the corresponding action. After completing the above operations, use the LoadRunner controller to create a real load environment. Configure the global operating parameters, Start () Vusers sets the total number of loaded users to 20, and executes them twice every 15 seconds. The duration parameter is the time that the created virtual user continues to run in the system. The StopVusers parameter is the number of users stopped within the set time. If the user fails to run or does not run, it is displayed as down, and if all users run successfully, it is displayed as passed. The system performance test results are shown in Table 4 and Figure 7.

As can be seen from Table 4 and Figure 7, through the above operation to test the system, create 200 virtual users, the total number of users logged in within 10 minutes is 197, the login success rate is 99.92%, the system response time is 2.02s CPU and memory usage are less than the target value. It can be seen from this that the system performance designed in this paper can meet the expected goals.

Table 4. System performance test results

Test content	Actual value	Expected value	Test Results
System response time(s)	2.02	10	Test passed
System login success rate(%)	99.92	99.9	
System business success rate(%)	99.97	99.9	
Total system login	197	200	
CPU usage(%)	67	70	
Memory usage(%)	65	70	

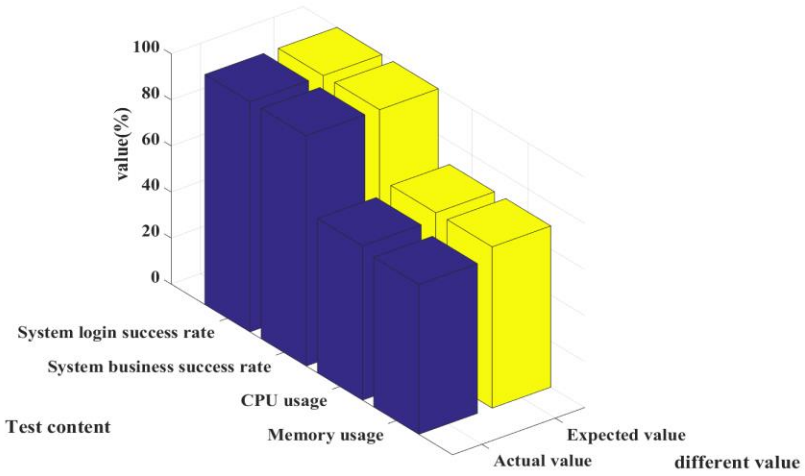

Figure 7. System performance test results

5. Conclusion

(1) In view of the poor performance of the existing schemes in traceability efficiency, this paper conducts in-depth research on the relevant theories and technologies of the blockchain, and proposes two traceability schemes based on reverse stitching and a traceability scheme based on reverse order recursion the solution, through the design and completion of comparative experiments and comparative analysis of the test data, found that the traceability scheme based on reverse order recursion had better performance.

(2) This article designs and implements a blockchain-based agricultural product supply chain traceability system, which mainly includes a display layer, a business logic layer and a network & data layer, which implements user management, agricultural product source information release, agricultural product receipt information release and agricultural products supply chain traceability and other functions, and after subsequent tests, the test results show that all the functions of the system designed in this paper work stable and run smoothly, reaching the expected results of the paper.

(3) This article mainly uses the personal computer to simulate and verify the experiment, so the web application is written, but it is not suitable for operation in the actual operation and agricultural work environment, so you can consider developing more various types of clients, such as mobile clients such as android and ios, to meet the needs of different working environments.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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