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Construction of Fresh Agricultural Product Supply Chain Traceability Platform Based on Alliance Blockchain

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***Abstract*—Aiming at the problems of scattered data, information asymmetry, multi-source heterogeneity, and low security in the traceability system of agricultural product supply chain, this paper designs a fresh agricultural product data traceability platform based on the consortium blockchain, realizes the registration of multiple users and the storage of internal sensitive information through the blockchain smart contract technology, This platform designs a traceability structure based on the actual needs of the traceability system of the fresh agricultural product supply chain, and further ensures the safety and reliability of the transactions of all parties in the fresh agricultural product supply chain.**

Keywords: Blockchain; Supply Chain; Smart Contract; Traceability.

I. INTRODUCTION

In recent years, food quality and safety issues have frequently appeared. From the perspective of market demand, consumers not only pay attention to the price of agricultural products, but also pay more attention to whether the agricultural products are green, healthy and safe. It is impossible to timely and accurately obtain and reflect the quality of fresh food during transportation. However, once there is a safety problem with the product quality, it is difficult to quickly and accurately identify the source of the problem. Therefore, researching and establishing the traceability system of agricultural products and realizing the effective supervision of the whole process from production to consumption has become a hot issue of common concern in various countries[10][6].

The characteristics of blockchain technology such as distribution, decentralization, security, non-tampering and traceability can well solve the trust problem between multiple links in the traditional traceability system and establish a reliable mutual trust mechanism[5][11]. Ma et al. [9]designed and implemented a trusted traceability system for the origin of agricultural products based on NB-IoT. Liu et al.[8]found that the technical characteristics of blockchain are suitable for solving the problems of long transaction process, unfair prices, and opaque transactions encountered in the circulation demand of agricultural products. Gao et al.[7]built a strong trust traceability application system, the key information of the entire industry chain of the entire brand of agricultural products is strong and cannot be tampered with and cannot be forged. Zhang et al. [3] proposed a secure and trusted agricultural product traceability system (BCST-APTS) supported by blockchain technology and CP-ABE encryption technology, which sets access control policies through data attributes, this strategy can encrypt data on the blockchain.

Combing the literature, it can be found that blockchain technology has been widely used in the field of traceability of agricultural products, but there are few studies on traceability of fresh agricultural products. The properties of fresh products are different from other products. The shelf life is relatively short, and cold chain preservation is required. During transportation, the transit time of fresh food is minimized. However, our country's current cold chain infrastructure is relatively weak. Therefore, this paper realizes the construction of a traceability platform for fresh agricultural products based on blockchain technology. Through the immutability of the smart contract layer, the response rules are preset and based on data integrity, to ensure that there is an authentication process in each link, and timely Discovery and accountability in a timely manner, complete information circulation and transmission, and provide decision-making and support for third-level users in the traceability of fresh agricultural products.

II. BLOCKCHAIN TECHNOLOGY

A. Basic Concepts of Blockchain

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Blockchain is essentially a technology that uses encryption to store transaction data as reliable and highly transparent digital information. Its purpose is to solve the problem of establishing a strong trust relationship between transacting parties and provide other participants with access to digital information. And the core technologies of blockchain include cryptography, distributed data storage, smart contracts and consensus mechanisms. These technologies can effectively prevent the stored data from being tampered with. At the same time, relying on the characteristics of decentralization, the cost of trust can be significantly reduced[9].

The research on blockchain technology is getting deeper and deeper, and the rapid development of blockchain technology makes the blockchain framework constantly changing, making many traditional modules gradually weakened. In this paper, the framework of blockchain technology is simplified into four layers, namely data layer, network layer, consensus layer and contract layer, as shown in Figure 1.

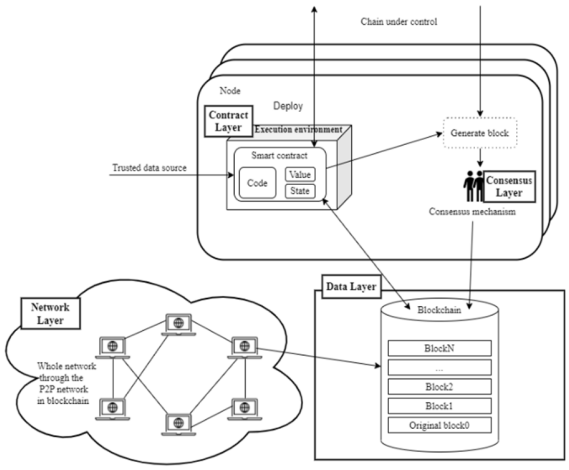

Figure 1. Framework of blockchain technology

B. Smart Contract

The concept of "smart contract" was first proposed by Nick Szabo in 1995, which is defined as a set of commitment terms in the form of digital information. It is a kind of digital contract, including the relevant contents that the transaction participants can enforce these terms. It allows trusted transactions to be carried out without third-party guarantees, and these transactions are traceable and irreversible. Therefore, it can be said that smart contracts are one of the key features of blockchain technology. "Blockchain + smart contract", as the core technology of blockchain, has been widely used in influential blockchain projects such as Ethereum and Hyperledger[1].

The completion of the smart contract operation mechanism in blockchain also requires the cooperation between the four layers. Smart contracts have two properties: value and state. If-Then and What-If statements are used in the code to preset corresponding triggering scenarios and response rules of contract terms. The smart contract code written in the development language generally cannot be directly run on the blockchain, but needs to be executed in a specific environment. Smart contracts are submitted and invoked through "transactions." When the user initiates and submits the contract file in the form of a transaction, the contract file is broadcast on the whole network through the P2P (Peer to Peer) network in the network layer, and stored in the block body of the data layer after verification by each node. Then the verified valid transaction is packaged into the new block. After consensus is reached through the consensus mechanism of the consensus layer, the new block is added to the main chain of the blockchain.

C. Blockchain Alliance

According to the access mechanism of blockchain nodes, the current blockchain can be divided into three categories: public chain, alliance chain and private chain. Public chain is a completely open blockchain, that is, any participant can join the chain and participate in the complete consensus accounting process, with the characteristics of complete decentralization. Alliance chains and private chains are semi-open blockchains, in which only designated members can join the network and each member has different permissions within the chain. Private chain means that the authority is only owned by internal members. Although the transaction efficiency is higher and the cost is lower than the public chain, the degree of decentralization is not obvious. The nodes can join the network only after being authorized, and all or part of the functions are available to the members of the alliance.The alliance chain can be regarded as a combination of public chain and private chain. The members in the alliance chain restrict each other, which can not only prevent self-management problems like those in the private chain, but also balance decentralization and efficiency.

III. THE OVERALL FRAMEWORK OF THE TRACEABILITY MECHANISM OF FRESH AGRICULTURAL PRODUCTS BASED ON THE ALLIANCE BLOCKCHAIN

This paper takes the alliance blockchain technology as the core of the traceability mechanism to build a traceability system for fresh agricultural products. The whole system mainly includes four parts: fresh agricultural product supply chain, cloud database, blockchain and supervision, as shown in Figure 2.

The platform of this paper did not actually land, but based on theoretical analysis, tried to apply blockchain technology to build a digital platform for fresh agricultural products traceability, and based on this platform to discuss the optimization path of fresh agricultural products supply chain system, which has important inspiration significance for the construction of the industrial supply chain.

The system divides fresh food supply chain users into three different types of identities, namely distributors, consumers and

regulators. Among them, distributors and consumers are collectively referred to as traders. The main user rights include: the trader's node mainly responds to block generation and credit evaluation generation when the transaction is completed, and saves the transaction records related to itself; the regulator's node conducts regular inspections from all nodes of the distributors, so as to supervise and manage the distributors in the fresh agriculture supply chain; the regulator is a collection of regulatory nodes, which has the highest authority to manage the authentication, authorization and monitoring of traders. It can access and manage all information of traders in the whole blockchain, and also maintain complete records of traders. The functions of each layer of the framework are as follows:

A. Cloud data layer

The cloud data layer is equivalent to the data layer of blockchain technology. It is used to design the data structure of the block. The block header contains a timestamp, and the contents of the block body are encrypted with hashing algorithms in an asymmetric form, so that the contents can be verified by different nodes, and the blocks are linked together to form a chain structure. The storage content mainly includes all the data of the whole process of the supply chain of agricultural products, such as the details of the cultivation of fresh agricultural products, the certificate of origin and production time, the warehousing and storage time of fresh agricultural products, the pricing and distribution channels of the products in sales, logistics data of products and market survey data, etc. Considering the huge amount of traceability information of fresh agricultural products, it may lead to low efficiency of blockchain operation if stored on the blockchain. Therefore, the system stores all the original data in the cloud database, and then stores the hash values of data in each link in the blockchain, so as to reduce the burden of blockchain and improve the operation efficiency.

B. Block chain layer

A block chain consists of an ever-growing list of records, called blocks, that are linked and secured using cryptography. Each block typically contains a hash pointer that acts as a link to the previous block, a timestamp, and transaction data. All information about traders or transactions is stored in blocks. Block chain layer includes data layer, network layer, consensus layer and contract layer. The data layer is transparent and tamper-proof, which can effectively avoid the risks caused by "information asymmetry" in the supply chain.

The network layer mainly ensures the accountability system and privacy. According to the elements of network access management and identity authentication mechanism, the block chain is distributed and stored in the relevant node database, which ensures the normal operation of the block chain from the technical level and the peer-to-peer communication rules of block information on the network.

The consensus layer has security and supervision. The establishment of this layer mainly includes consensus algorithms such as POS (Proof of Stake), POW (Proof of Work), PBFT (Practical Byzantine Fault Tolerance), BFT (Byzantine Fault Tolerance), etc., and uses the authorization of shares (DPOS) and other access methods. The consensus mechanism can reach an effective consensus on the data of each node in the traceability system of fresh agricultural products. This mechanism strictly reviews the business qualifications of supply chain entities to ensure that their business is legal and compliant.

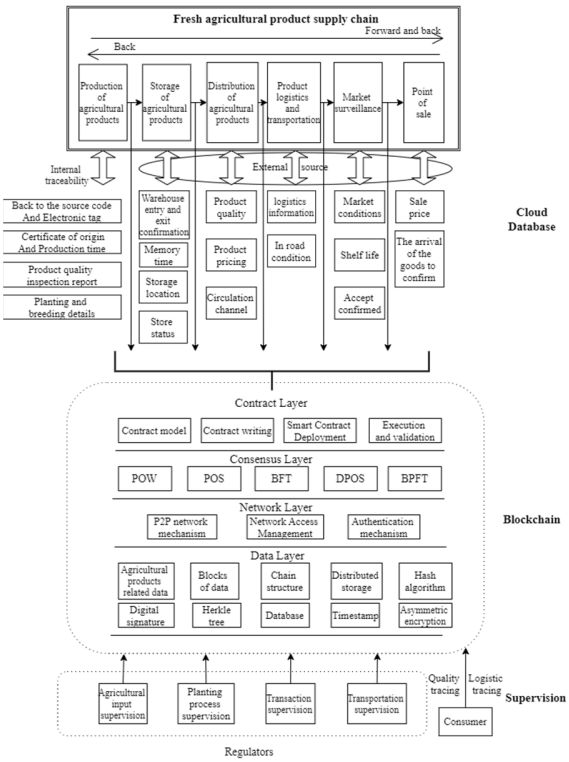

Figure 2. Framework of fresh agricultural products traceability platform

The contract layer guarantees reliability, mainly including national laws, policies, standards and regulations on agricultural products and other important documents, as well as various agricultural products contracts signed between supply chain subjects.For the sensitive information involved in the internal privacy of fresh agricultural products enterprises, the complete and strict confidentiality mechanism of the original product information and the information exchanged between multiple subjects is designed through the smart contract.

C. Regulatory layer

The regulatory part corresponds to the application part of the overall architecture and can also serve as an intermediary between regulatory units, consumers, and commodity information in the traceable chain. Regulators can let customers see the logistics information of fresh agricultural products and the record of the whole process of product production, so as to facilitate the traceability of product quality and goods.

IV. AGRICULTURAL PRODUCT TRACEABILITY SERVICE BASED ON CONSORTIUM BLOCK CHAIN

The fresh agricultural product traceability service is to use the distributed storage node nature of the block chain to collect the basic data of fresh agricultural products from the intelligent IoT terminal. Multiple management entities are set up inside the platform, infiltrating multi-process management sovereignty, and at the same time holding the analysis

guarantee of the big data processing center to minimize the possibility of forging information.

The main business process of the platform consists of three main levels. The first level is the business handover between processing enterprises, farmers and dealers. In this process, processing enterprises gather multi-level distributors by themselves, production, operation and sales activities are open and transparent on the platform, and data is shared by enterprises on the chain, which is convenient for the next layer, financial institutions and regulatory agencies to conduct real-time supervision.

The second level is the business handover between all the subjects of the first level, regulators and consumers. The regulatory agency needs to input and record the amount of credit assets transferred based on the transaction credit of farmers, processing enterprises, and dealers. Once the transaction is confirmed, The blockchain automatically executes smart contracts to ensure instant settlement, payment, provenance, and security of transactions.

The third level is the handover between the traceability platform and the above two-level processes. The blockchain-based traceable agricultural products realize the whole process of online operation, and each subject can conveniently and efficiently conduct transactions, production, supervision, and tracking of various process operations on the platform. Online transactions form a chain community of farmers, dealers and processing enterprises, with the right to view product price trends, bids and quotations and other information.

In general, the first-level entities actively participate in the ecological development of the entire process after being supervised and granted credit by the regulatory agencies; the second-level entities are based on the regulatory system, and the increase in credit reflects the reliability of the actual transaction credit; the third-level handover The whole-process traceability operation provides a complete platform traceability system.

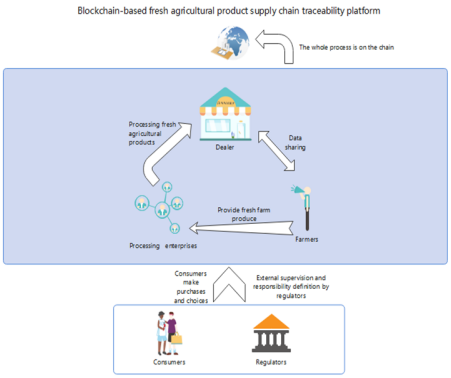

Figure 3. Realization of business process of traceability service for fresh agricultural products

V. Conclusion

Considering the logistics characteristics of fresh agricultural products, this paper takes the alliance blockchain as the technical core, builds a fresh agricultural product traceability platform, builds a multi-level and decentralized core architecture, realizes multi-process information interconnection and sharing, and achieves high efficiency throughout the process. The traceability platform designed in this paper can promote the transformation and upgrading of the supply chain of traditional fresh agricultural products and promote the healthy and sustainable development of rural economy. In the future, the research and improvement of this platform will be further improved in terms of practice.

Acknowledgment

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