Application of Blockchain Technology in Agricultural Product Traceability System

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Abstract: In recent years, the safety of agricultural products has become increasingly serious. The traditional traceability system of agricultural products is faced with the lack of credibility, regulatory difficulties and scalability problems. The quality and safety traceability of agricultural products is imminent. With the continuous development of blockchain technology, its distributed, decentralized, tamper-proof, traceable and other features play an important role in improving the security and transparency of agricultural product traceability system data, and have been widely concerned by various industries. On the basis of expounding the necessity of agricultural products traceability, this paper proposes to build a "Four-level" system architecture of traceability system of agricultural product based on blockchain, so as to realize the internal consistency between blockchain technology and the traceability system,. Combined with the operation process of agricultural product supply chain, this paper studys the operation process of the traceability system, so as to achieve the whole process traceability of agricultural product supply chain.

1. Introduction

Agricultural products refer to food, vegetables and fruits, livestock and poultry, milk, eggs, fungi, aquatic products, etc. required by human daily life. Agricultural producers, manufacturing industries, distributors, retailers and even end customers need to participate in the circulate course from production to consumption. Especially in the new technology era, the blockchain technology studied in this paper will affect and change the supply chain of modern agriculture. The quality and safety of agricultural products is not only the basic guarantee of food safety, but also the important task of high-quality development of modern agriculture. At present, there are still many risks and hidden dangers in the quality and safety of agricultural products, such as the illegal addition of inputs and the excessive level of agricultural residues, which are directly related to people's livelihood. The quality and safety of agricultural products is not only the internal requirement of national food safety, but also the need to meet the upgrading of people's consumption, which is of practical necessity. Establishing the quality traceability system of agricultural products is an effective way to solve the quality and safety problems of agricultural products widely used at home and abroad.

2. Current Situation of Agricultural Product Quality Traceability Industry

Since the 18th CPC National Congress, the CPC Central Committee has adhered to the people-centered development thought and made overall planning and deployment for food safety work in the overall layout of "five in one" and the strategic layout of "four comprehensives", so as to improve the supervision ability of the whole process from farmland to dining table and improve the quality and safety guarantee level of the whole food chain. It is further proposed to gradually realize the docking of enterprise information traceability system with government department supervision platform and important product traceability management platform, so as to accept government supervision and share information with each other. With the dual support of market demand and national policies, the food traceability industry has become an emerging hot industry and has broad market development prospects. The traditional food traceability system adopts a centralized database to save data. All information related to food, including a series of supply chain and transaction information of processing manufacturers, is stored in a large core database. This storage method often has no too strict restrictions on data modification, and the data source is completely determined by the food owner. This means that the use of traditional food traceability system will greatly reduce the authenticity and safety of food information, and the government's supervision and beneficiaries cannot guarantee the reliability of data, causing consumers to fall into a crisis of trust in food safety. To solve this problem, the introduction of blockchain into food traceability system can be effectively solved[1,2].

3. Research Status of Traceability of Agricultural Product Quality and Safety

At present, the concepts of traceability and traceability system have not formed a unified definition. Relevant organizations and scholars at home and abroad have elaborated and explained them from different perspectives, as shown in Table 1. Traceability was originally proposed by some European Union countries such as France. The European Union, the United States, Japan and other developed countries have formulated relevant laws for this purpose and strictly stipulated the requirements for food traceability.

The research on the traceability system was initially established by the European Union in 1997 to deal with the problem of mad cow disease. Its conceptual definition is shown in Table 2. At present, China supervises the whole process of agricultural products from planting to consumption, forming an information system integrating production, supply and marketing. The tracing process can be divided into two types: one is forward tracing, that is, tracing from upstream links to downstream links according to the life cycle of agricultural products; The second is reverse traceability, that is, from the downstream link of the industrial chain to the upstream link. Yang Xinting and others believed that traceability is the characteristic and ability of product supply chain tracking and traceability, and the traceability system is the method, model and system to achieve traceability through certain technologies. Although there are differences in the concept description between traceability and traceability system, their connotation remains unchanged. They are both intended to promote the transparency of production information, improve the quality and safety of agricultural products, and enhance the market competitiveness of agricultural products. According to the data management mode, the traceability system of agricultural products is divided into centralized system and decentralized system. At present, most of the traceability systems used in enterprises are centralized. The traceability system mainly includes such basic elements as individual identification, central database, information transmission system and individual mobility registration. Its system architecture is roughly divided into physical layer, communication layer, database layer and application layer. The traditional agricultural product traceability system uses B/S network architecture to store data in Oracle, SQL and other databases on the server. At the

same time, the entire agricultural product traceability system has a central database, which is under the supervision of authoritative institutions, the government and relevant standard organizations to centrally manage the traceability data. However, the authenticity of information transmission cannot be guaranteed, which is easy to form an information island, causing consumers to question the information provided by the system. The traceability effect is not ideal. In view of the existing problems, a large number of scholars proposed to combine the blockchain and the Internet of Things to improve the reliability of the traceability system at the technical level.

Table 1: Traceability concept

Source	Definition
EU regulations No.178/2002	The ability to trace food, feed, livestock products and feed raw materials at all stages of production, processing and circulation
Food Trademark Committee	The ability to trace any specified stage of food production, processing and circulation
ISO 2005;2007	The ability to track the flow of feed or food through specific stages of production, processing and distribution
Chen Song et al	Once the safety problems endangering human health are found, the information that must be recorded in all links from the listing of raw materials to the final consumption of finished products can be traced to the flow direction, recalled the problem food, and cut off the source to eliminate the hazards

Table 2: Traceability System Concept

Source	Nature	Definition
European Commission	Agricultural product traceability system	The system for tracking agricultural products (including food, feed, etc.) at all stages of entering the market (the whole process from production to circulation) is conducive to quality control and product recall when necessary
Food Trademark Committee	Food traceability system	Provide continuous guarantee capability for information flow in all stages of food supply chain
Chen Honghua et al	Agricultural product traceability system	Record and store various relevant information of the product in the whole process of product supply

4. Feasibility Analysis of Building Traceability System for Blockchain

4.1. Blockchain Technology is Traceable

Agricultural products are an essential part of people's survival. Food safety of agricultural products is related to people's livelihood. Therefore, agricultural products need to be strictly controlled from planting, production and processing, warehousing and transportation. Blockchain technology can completely record the information of the entire procedure of agricultural products from the origin to consumers. Once a problem occurs in a certain link, it can trace the source according to the complete information recorded in the blockchain, implement the relevant responsible subjects, and recover the agricultural products with quality problems to avoid

unnecessary losses[3].

4.2. Blockchain Technology Has Anti-counterfeiting Characteristics

Now there are some non organic agricultural products on the market, but they are labeled as organic agricultural products. In order to prevent this phenomenon, blockchain technology can be used to completely record the whole process of agricultural product transfer and can not be tampered with. This makes the Circulating information of agricultural products from planting to mature processing and finally to consumers unique, ensures the integrity and authenticity of data in the circulation process, and realizes "one object and one code"[4].

4.3. Blockchain Technology is Decentralized

The market circulation of agricultural products involves the participation of various subjects. Although the traditional traceability system has a certain role, but the cost is high. The blockchain can adopt its decentralized function to cut down the trust cost among participants, realize trust sharing among participants, integrate the information of the entire course of agricultural production and circulation and record it on the block, reduce the traceability cost and improve the circulating efficiency [5].

5. Quality and Safety Traceability System of Agricultural Products Based on Blockchain Technology

The traceability system of agricultural products based on blockchain technology realizes the monitoring and control of the entire course from the purchase of agricultural materials such as seedlings and pesticides to the delivery to final consumers with the help of blockchain technology, forming an integrated information system of "production-supply-marketing- consumption". The study on the quality and safety traceability system of agricultural products based on blockchain technology includes traceability system architecture, management role and operation process. By constructing the "four level" system architecture, the goal compatibility of the three types of management subjects is realized, and then the operation of the traceability system is jointly promoted[6,7].

5.1. Traceability System Architecture of Agricultural Products Based on Blockchain Technology

In 2008, a mysterious man with a pseudonym of "Satoshi Nakamoto" first proposed the concept of blockchain in Bitcoin: A Peer to Peer Electronic Cash System. Blockchain is derived from the technical application of Bitcoin. It is the underlying technology that supports the encrypted transmission of Bitcoin and transaction information. It mainly solves the trust of transactions and the security of payment. It is a chained data storage structure that combines data blocks in a sequential manner according to the time stamped order of information, and ensures that information data cannot be tampered with and forged by means of cryptography. Compared with traditional traceable anti-counterfeiting technology, blockchain has four advantages: decentralization, consensus trust, collective maintenance, and secure database. With these four advantages, the application of blockchain technology is not limited to digital currency encryption. Smart contracts, authentication, container sharing, e-commerce, the Internet of Things, equity crowdfunding, etc. are all application scenarios of blockchain technology, gradually forming the development trend of "blockchain+". Blockchain technology is applied to the construction of the traceability system for

the quality and safety of agricultural products. It is difficult to ensure the integrity and authenticity of the traceability information at this stage, low social trust in the traceability information of agricultural products, high traceability costs caused by small-scale and low-grade traceability subjects, and difficult management, low efficiency, lack of effective business models and other problems of the existing traceability system for the quality and safety of agricultural products, It plays an important and positive role.

The traceability system of agricultural product quality and safety based on blockchain technology, with the help of blockchain technology, realizes the monitoring and management of the whole process of agricultural products from the purchase of seedlings, pesticides and other agricultural materials to the delivery of final consumers, forming an integrated information system of "production, supply, sales and consumption". The research on traceability system of agricultural product quality and safety based on blockchain technology includes three aspects: traceability system architecture, management role and operation process. Through the construction of a "four tiered" architecture, the objectives of the three types of management subjects are compatible, thus jointly promoting the operation of the traceability system.

The quality and safety traceability system architecture of agricultural products based on blockchain technology is based on the hierarchical structure of blockchain system and superimposes the operation rules of the traceability system o. In addition, due to the large number of subjects involved in the whole link of the agricultural product industry chain, it is more difficult to trace the information. The superiority of blockchain is to provide a good data storage scheme for the traceability system, and does not have the function of preventing superiority information from being written into the blockchain[8].
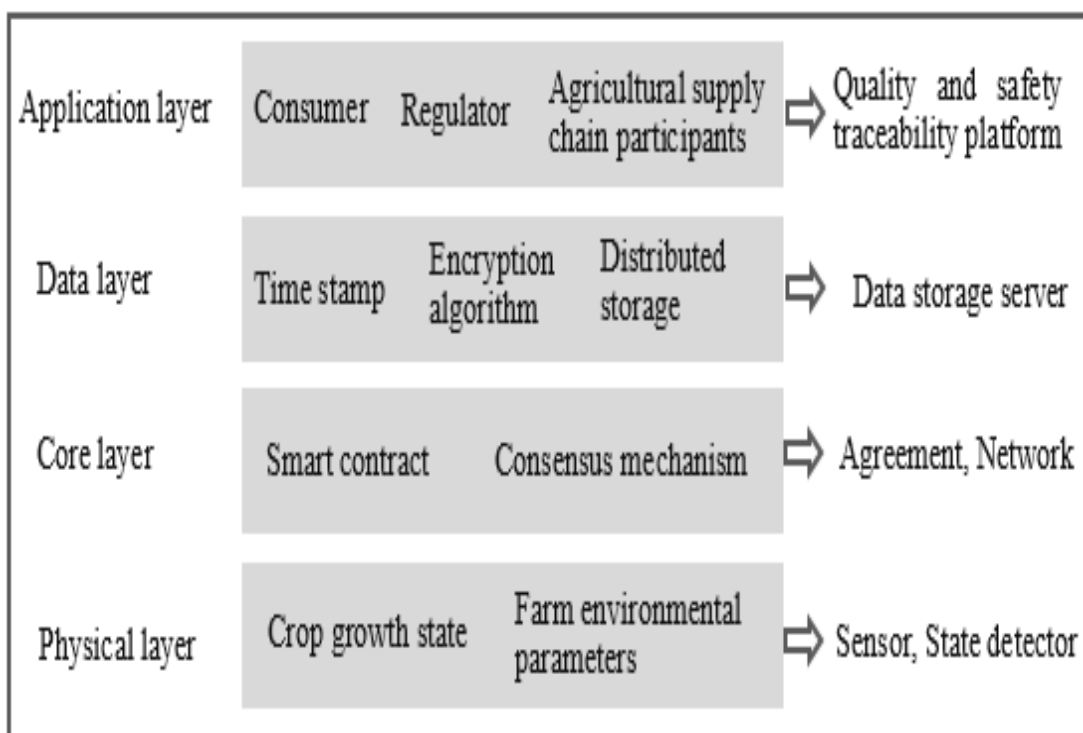

Figure 1: Framework diagram of agricultural product traceability system

Therefore, the Internet of things is introduced to dynamically track the status of agricultural products, so as to improve the objectivity and accuracy of the information. It is divided into utilization layer, data layer, core layer and physical layer according to different functions. Based on the physical layer, the "object" is included in the "block" through information collection; With the

core layer as the guarantee, it ensures the compatibility of the objectives of front-end consumers, traceability information providers and regulators through smart contract and consensus mechanism; Focus on the data layer, it avoids the problem of "information island", and improve the traceability accuracy through distributed management; Based on the application layer, the B / s technology architecture is adopted to realize the binding of people and things. Among them, blockchain technology is mainly applied to the core layer and data layer, as shown in Figure 1.

5.2. Traceability System of Agricultural Products Based on Blockchain Technology

In order to quickly and accurately trace the production place, planting place and relevant responsibilities of various participants in the circulation process, a traceability system based on blockchain technology is constructed under the framework of the traceability system, as shown in Figure 2. In the planting of agricultural products, intelligent detectors such as sensors and controllers are used to record the environment of the planting base, such as temperature, humidity, pesticide concentration and other relevant data, and put on the chain for filing. In the processing link, the processing enterprise's own information and processing environment and other relevant information shall be linked for filing. In the warehousing, transportation and circulation link, the relevant registration information of the logistics company is recorded on the chain, and the storage environment and transportation vehicle environment such as temperature and humidity are recorded and stored in the block[9]. The regulatory authorities supervise through the blockchain information platform to guarantee the quality of agricultural products and food. Consumers can scan the code for information query through the platform to prevent fake and shoddy organic agricultural products.
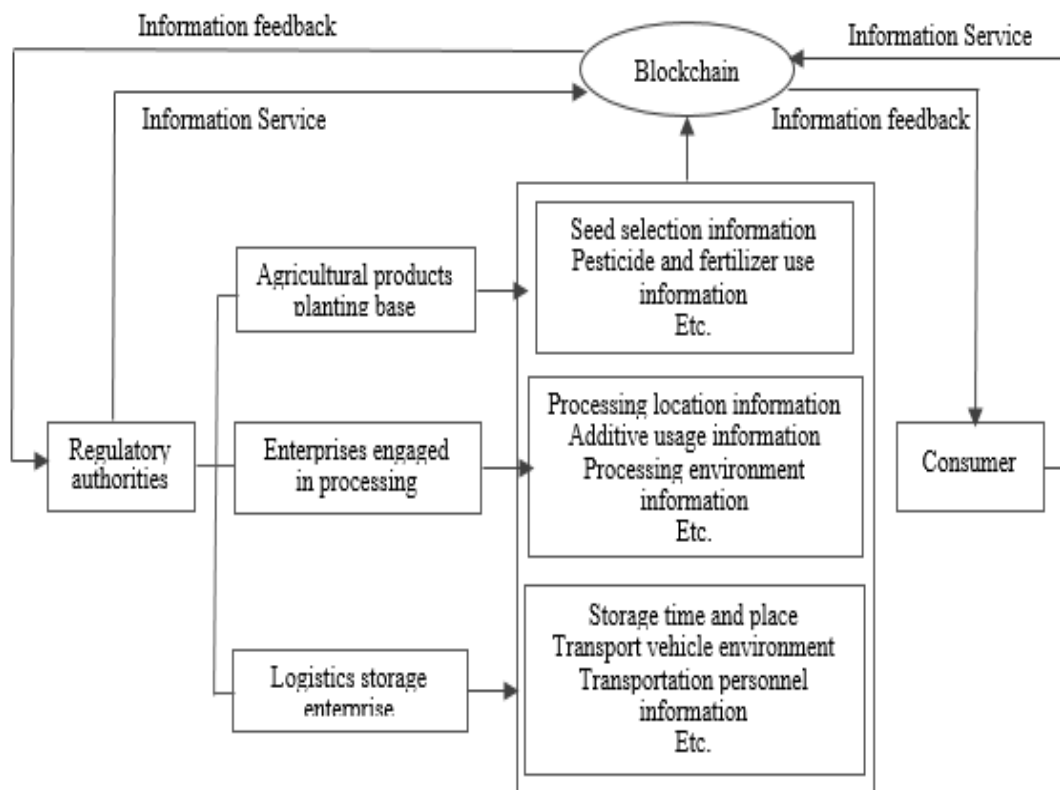

Figure 2: The raceability system based on blockchain Technology

6. Conclusion and Prospect

Both blockchain technology and food safety issues have been highly valued by the state. The blockchain technology is applied to the traceability of food safety information. By taking advantage of the feature of decentralization, non distorting, openness, transparency in the blockchain, the whole process traceability of food safety information is truly realized technically, so as to guarantee the truth, safety, transparency and integrity of all data on the whole traceability chain[10]. The combination of blockchain and food traceability has become a hot spot. In the future, we can combine the characteristics of food supply chain and make full use of Internet of things technology to construct an smart food safety traceability system.

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