ISSN 2616-7433 Vol. 5, Issue 6: 78-83, DOI: 10.25236/FSST.2023.050612

Research on the application problems and countermeasures of blockchain in the traceability and circulation of agricultural products

Qin Qiongxian, Guo Zijing[a,*]

School of Economics and Management, Guangxi Normal University, Guilin, China
[a]gzj495@stu.gxnu.edu.cn
**Corresponding author*

Abstract: *With the improvement of Chinese residents' consumption level, people begin to put forward higher requirements for the safety, information transparency and query convenience of agricultural products, so it is particularly important to trace the source of agricultural products. This paper will comb and summarize the research and application of blockchain-based traceability system at home and abroad in recent years, and then study the current problems of blockchain traceability, and then explore the correct steps to build the traceability model of blockchain agricultural products. Finally, three suggestions are made to improve the application of blockchain agricultural products traceability in circulation, in order to provide reference for the research and establishment of blockchain agricultural products traceability system.*

Keywords: *blockchain; agricultural product traceability; traceability model; circulation application*

1. Introduction

The traceability of agricultural products is a necessary condition to ensure the quality and safety of agricultural products, and it plays an important role in the field of food safety [1]. Traditional agricultural products traceability depends on the storage and management of data in the central database, which leads to the problems in the recording process of information that is easy to be tampered with, data is not open and transparent, and information is easy to be lost [2]. As a key technology of agricultural digitalization, blockchain has a series of characteristics such as decentralization, openness and transparency, and tamper-proof [3], which can effectively solve the core problem of agricultural product traceability. In recent years, the world has a block chain traceability, the blockchain White-Paper (2022), points out that as of September 2022 global total block chain related enterprise 6941, including China block chain enterprise has more than 1400, ten batch of BaaS (Blockchain as a Service) for the record list block chain traceability application reached 10%, in the top three. On February 13, 2023, "No. 1 central document" for 2022 proposed to strengthen the supervision of food safety and the quality and safety of agricultural products, and to improve the traceability management system. In China, government departments, enterprises and scientific research institutions are actively promoting the application of blockchain technology. Zhongan technology combines the blockchain traceability system with chicken raising, and the information of every step from the birth of chicken seedlings to slaughter is recorded and uploaded to the blockchain through sensors to save [4]. Ant Chain, a subsidiary of Ant Financial, develops [5], a green food traceability platform based on blockchain technology; abroad, GST International Traceability Chain (GSTCOIN) is a decentralized commercial application platform that can provide payment transaction traceability. The traceability projects in the United States are widely distributed, mainly involving seafood, fresh beef, ice hockey surrounding commodities, coffee and drugs. In Europe, the retail giant, Nestle. As early as April 2019, Carrefour cooperated with IBM to use IBM blockchain technology to track the Mousline supply chain of the French mashed potato brand Mousline. Consumers can scan the QR code on their smartphones to understand the source of the mashed potatoes and information about the entire supply chain. There are multiple coupling [6] of blockchain technology in the circulation field of agricultural product traceability. Therefore, through studying the current problems of blockchain traceability in China, this paper proposes the steps of building blockchain agricultural product traceability model, and finally puts forward the improvement countermeasures of blockchain agricultural product traceability.

ISSN 2616-7433 Vol. 5, Issue 6: 78-83, DOI: 10.25236/FSST.2023.050612

2. Blockchain, agricultural products, traceability of the literature review

Research on the traceability system began in 1997 after the European Union responded to the mad cow disease problem [7]. In 2006, China proposed to establish an agricultural product quality and safety traceability system with "segmented and segmented" management characteristics [8]. Later, Chinese agricultural products began to explore the whole process information traceability system from farm to table. The traceability process is mainly divided into two kinds. One is forward tracking, that is, tracking [9] from the upper, middle and downstream according to the circulation process of agricultural products; the second is reverse traceability, that is, tracing [10] from the downstream of the industrial chain. In 2008, the concept of blockchain originated from the proposal of Bitcoin, and "Satoshi Nakamoto" was gradually known by the public in Bitcoin: A peer-to-peer electronic cash System as the underlying technology to establish the concept of Bitcoin [11]. Later, blockchain traceability technology has been applied in many industries, while China's blockchain is in the exploratory stage of process of agricultural application, and the agricultural field is mainly used in the product circulation, product traceability, financial transactions and other aspects of [12]. The traditional traceability method is mainly around barcode, QR code and RFID technology. There are disadvantages such as replicable anti-counterfeiting identification, difficult operation of anti-counterfeiting process, low credibility of anti-counterfeiting information, and single anti-counterfeiting function [13], which affect the trust of consumers. Later, Liu Jiaji designed two sets of blockchain traceability systems of public chain and private chain to solve the problems of product label replication, spam and problem positioning [14] in traditional product traceability system. Li Tianming et al. [15] believe that the integration of blockchain and Internet of Things framework has the advantages of safe, reliable, transparent and open, and has become one of the most compatible and useful frameworks in blockchain applications. Liu Shuangyin et al. [16] proposed the coordinated management and Kafka consensus mechanism to establish the quality, safety, efficient and credible traceability system of agricultural products. Li Xuan et al. [17] proposed the dual-block chain anti-counterfeiting traceability system, which passed the verification of the security and simulation feasibility of the traceability system. Chunhua [18] separate the traceability process from the verification process and build an image-based interactive traceability structure. XueYan [19] study the supply chains of two manufacturers and retailers using blockchain technology, and find that consumer awareness of traceability is related to blockchain-based traceability cost sharing between manufacturers and retailers.

The existing literature based on blockchain traceability is more about the establishment of traceability architecture, mainly used in logistics, finance and other fields, and less discussed in the research in the traceability of agricultural products. Therefore, this paper studies the current problems of blockchain traceability, and then puts forward the steps of constructing the traceability model of blockchain agricultural products, and finally puts forward the application improvement countermeasures for the problems.

3. Problems existing in the application of blockchain agricultural product traceability

Although blockchain technology has a great prospect of application in the field of agricultural product traceability, there are still some problems.

3.1. The true integrity of the information input and the lack of standard formulation

First, the reliability of the blockchain technology is based on the authenticity of the information. The traceability of agricultural products involves multiple subjects, and the process is relatively complex. For the production link, manufacturers may input suboptimal product information into high-quality products for their own interests. If the information input is not true or timely, the reliability and effectiveness of blockchain traceability will be affected. Secondly, the whole process of traceability needs to record a large amount of data, including production, processing, transportation and sales information. These data need to be accurately collected, stored and managed, otherwise it will lead to incomplete or incorrect traceability information. Finally, the traceability of agricultural products involves multiple links, and each of them may involve different informational standards and norms. The traceability information of the same kind of agricultural products in different regions and different traceability systems is not unified. At present, there is no unified regulation on the depth of traceability. How to unify the information standard while ensuring the information comparability is a problem that needs to be solved.

ISSN 2616-7433 Vol. 5, Issue 6: 78-83, DOI: 10.25236/FSST.2023.050612

3.2. It is difficult to guarantee the privacy protection of traceability data

First, since the blockchain ledger is made public, anyone can view the information in it, and the public information on the chain may leak the technology and privacy data of merchants. Second, the data on the blockchain is stored permanently, and once the data is stored on the blockchain, it cannot be deleted or modified. This can lead to sensitive user data being kept on the chain for a long time, thus posing a risk to user privacy. Finally, the transactions on the blockchain are anonymous, but the transaction record is traceable. Although the individual user can be encrypted, every transaction will be recorded, which may lead to the user's identity and privacy information being exposed, thus causing risks to the user's privacy.

3.3. Infrastructure popularization is difficult and maintenance costs are relatively high

First of all, the block chain traceability system is a multidisciplinary combination of knowledge and skills, including the need for computer science to provide algorithm basis, mathematics provides cryptography research, economics to provide digital currency support and law, management and sociology, and also need with the development of the Internet of things and 5G technology, to realize the link interconnection, development is difficult. Secondly, in China, at present, the majority are operated by family farmers, and the scale and intensification of agricultural products in most areas are low, which restricts the application of blockchain technology in the traceability of most agricultural products to a certain extent. Finally, at present, the cost of establishing the blockchain agricultural products traceability system is high, mainly including the input of information of agricultural product, the information update and maintenance, system construction, which requires a large number of high-tech, compound talents and a large amount of capital investment, for small farmers and small and medium-sized enterprises, these are difficult to afford. Therefore, how to reduce the cost of technology application and improve the penetration rate of infrastructure is a problem that is worth thinking about.

4. Design steps for the blockchain model construction

Block chain agricultural traceability model construction, we should first determine what link in the process of traceability products, and in each link, such as production origin and production records, processing of food certification information, transportation circulation information and distribution channel information, etc., in order to realize the source of agricultural products can check, to can chase, responsibility to confirm. Second, it is necessary to design an appropriate data structure to store traceability information. Generally speaking, a chain structure can be used to store information. Each block contains a certain amount of information and the hash value of the previous block, thus forming an immutable chain structure. Third, appropriate consensus algorithms need to be selected to ensure data consistency and security. At present, the workload certificate, equity certificate and authority proof mechanism are commonly used. Fourth, the roles and functions of different nodes should be determined to ensure the normal operation of the system. Different nodes in the blockchain system have different roles and require some nodes to maintain the operation of the system. Fifth, appropriate smart contracts need to be built according to the requirements to ensure the security and reliability of the contract. On the premise of blockchain, the parties of the whole agricultural product industry chain can reach a mutual agreement and agree to meet certain conditions, and the smart contract can automatically execute the contract terms, so as to realize automatic traceability and verification. Sixth, it is necessary to determine the access rights and data protection mechanisms for different users to ensure data security and privacy. Information in the blockchain traceability model needs to be accessed and used by different users. Concerning sensitive information such as trade secrets and personal privacy, access needs to be controlled according to the identity and authority of different users. Finally, after the construction, the system needs to be tested and optimized to ensure the stability and performance of the system. The interface design and system need to be upgraded and maintained to ensure the security and privacy of data, and prevent data from being attacked and tampered, so as to adapt to different application scenarios and needs.

Figure 1 shows the traceability and circulation process of agricultural products. The first link of agricultural products is the planting environment, in which farmers are asked to check the information. They tested the seed source, analyzed the soil situation, recorded the chemical fertilizer application records, and formed the fruit after ripening. Then, to the next stage: the inspection link. This link is the first sampling of agricultural products, and into the relevant inspection base, for the laboratory inspection and pesticide use inspection. After the inspection is completed and qualified, and then enter

ISSN 2616-7433 Vol. 5, Issue 6: 78-83, DOI: 10.25236/FSST.2023.050612

the next link: wholesale and logistics links. When agricultural products enter the wholesale market or the distribution center, the storage time of shops and agricultural products, cold storage information and cold storage time shall be recorded. When wholesalers come to purchase, continue to conduct the information record, distribute agricultural products, distribution logistics and delivery time record; record the arrival time and shelf time, record the arrival time and compare the retail quantity of agricultural products; then enter the last link-after-sales service. At this stage, consumers can query the product information through the platform customer service consultation, reflect or complain about the product situation. In the after-sales evaluation, consumers can evaluate the agricultural products, and the information will be displayed on the blockchain network platform for more consumers' reference.

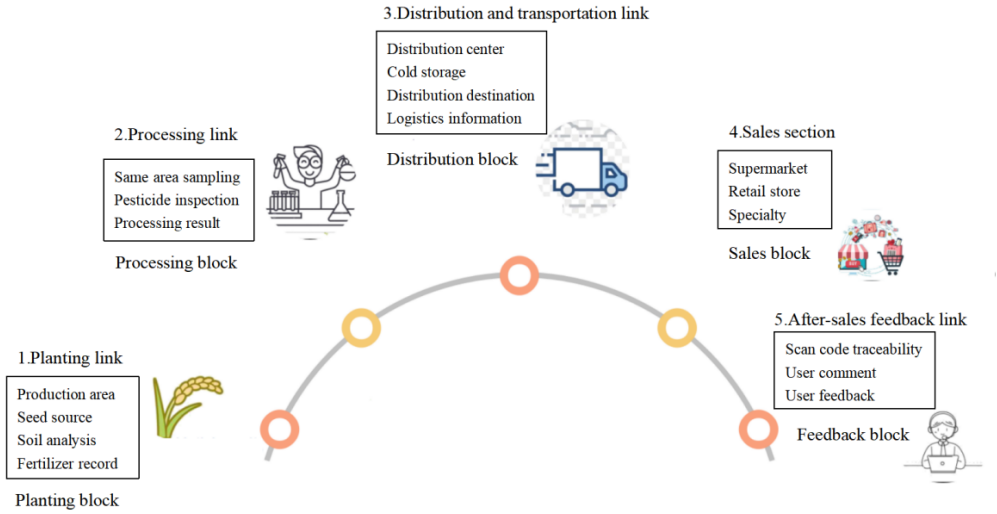

Figure 1: Flow chart of the traceability and circulation process of agricultural products

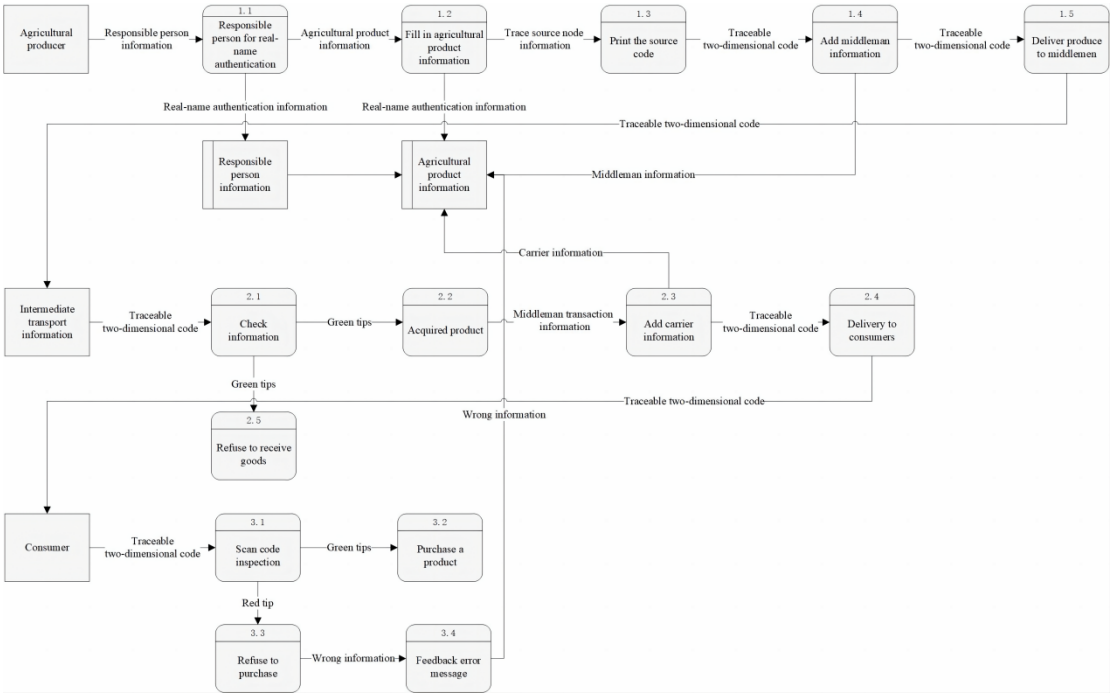

Figure 2: Information verification path of agricultural products in circulation

Figure 2 shows the information verification path of agricultural products in circulation. Realize the distributed storage link traceability information for point-to-point transmission. Establish mobile QR code storage information from the source, automatically verify the information on the previous subject on the link, if the information is complete and the previous information, the prompt will be green, and fill in the information of the transaction with the previous subject. The hash encryption algorithm can easily detect the advantages of whether the data is changed, and ensure the data security again. The

ISSN 2616-7433 Vol. 5, Issue 6: 78-83, DOI: 10.25236/FSST.2023.050612

Merkel tree algorithm stores information by using data structure of the chain. Establish a consensus mechanism to record the data of each node synchronously with the rules. Once the previous entity does not follow the consensus mechanism, the next subject will not trade with the product, and the traceable QR code is red. Consumers can know the problems with the product by scanning the code and will not buy it.

5. The countermeasures to improve the application of blockchain agricultural products

5.1. Strengthen the development of blockchain system standards

First, develop technical standards and specifications. We can refer to international standards and advanced experience to formulate technical standards and specifications suitable for the domestic market, standards for similar agricultural products in different regions and different traceability systems, and norms for the promotion of blockchain agricultural products traceability technology. Secondly, formulate industry standards and norms. Blockchain agricultural products traceability technology needs to realize information sharing and collaboration, and realize a standardized data sharing, exchange and management mechanism in the industry information exchange platform and mechanism. Finally, cooperate with various departments. We should strengthen cooperation and coordination among government departments, enterprises and scientific research institutions, establish a cooperation mechanism for the integration of industry, science and research, and gather all parties to jointly promote the formulation of standard rules.

5.2. Accelerate the research and development of blockchain traceability technology

On the one hand, it is necessary to continuously increase the research and development and innovation of blockchain agricultural products traceability technology, strengthen the construction of public technology platform, provide technical support and consulting services, and encourage enterprises and universities to strengthen technical research and talent training. On the other hand, strengthen industry self-discipline and supervision to ensure data security and privacy. In terms of the protection of private data, we should speed up the application of encrypted passwords and the construction of smart contracts, increase the protection of private data and trade secrets, and develop secure and reliable application solutions to meet the needs of different users and enterprises.

5.3. Increase government support for the application of blockchain traceability

First of all, the government can issue relevant policies and regulations to guide and assist enterprises to increase the construction of blockchain technology and infrastructure, encourage enterprises and producers to use blockchain technology for traceability, and support the application and development of blockchain agricultural products traceability technology. Secondly, join the third party of the regulatory authorities of government to increase the review and dynamic supervision of the reliability and consistency of traceability information, so as to improve users' recognition and trust of blockchain traceability products. Finally, the relevant intellectual property rights and user privacy should be protected to avoid the improper use of information. To stop violations of laws and regulations in time to avoid infringement of the legitimate rights and interests of all parties on the chain.

6. Conclusions

The natural features of blockchain, such as decentralization, immutable and smart contract, can solve the problem of product trust and make it have a wide prospect of application in the agricultural product traceability system. This paper analyzes the current agricultural traceability problems existing in the application, put forward the block chain, the block chain traceability process system architecture for the construction and analysis, using block chain point-to-point transmission way to realize consumers and agricultural information in circulation, solve the traditional agricultural traceability system centralized degree and node difficult consensus. However, because the research on blockchain technology is not yet mature, there are still some limitations in the specific application, so further unified standards are still needed to improve efficiency and increase promotion efforts.

ISSN 2616-7433 Vol. 5, Issue 6: 78-83, DOI: 10.25236/FSST.2023.050612

References

[1] Yang Jing, Liu Yiming, Zhang Qiaoying, Shi Xueping, Qin Yan. Current status and countermeasures of traceability of Agricultural products in China [J]. Zhongnan Agricultural Science and Technology, 2023, 44 (01): 222-225.
[2] Wu Xiaotong, Liu Pingzeng, Wang Zhihua. Research on agricultural products traceability system based on blockchain [J]. Computer Applications and Software, 2021,38 (05): 42-48.
[3] Su Zhen, Zhao Wenyan. Analysis and design of smart agriculture applications based on blockchain [J]. Agricultural Book and Information Journal, 2020,32 (3): 44-53.
[4] Faye Wong, Lu Ke. A brief analysis of the application of blockchain and agricultural Internet of Things in the aquaculture industry- -Take the "Walking chicken" of Zhongan Technology as an example [J]. Rural Economy and Science and Technology, 2020,31 (1): 71-72 + 360.
[5] Teodorescu M, Korchagina E. Applying blockchain in the modern supply chain management: Its implication on open innovation [J].Journal of Open Innovation: Technology, Market, and Complexity, 2021, 7(1): 80.
[6] Liu Ruyi, Li Jinbao, Li Xudong. Application mode and implementation of blockchain in the circulation of agricultural products [J]. China's circulation economy, 2020, 34 (03): 43-54.
[7] Schwaegele F. Traceability from a European perspective[J].Meat Science, 2005, 71(1): 164-173
[8] Wang Zhihua, Liu Pingzeng, Song Chengbao, Song Yunsheng, Zhang Chao, Zhang Yan, Wu Xiaotong, Zhao Kun. Research on the flexible and trusted traceability system for agricultural products based on blockchain [J]. Computer Engineering, 2020,46 (12): 313-320.
[9] Zhao Ti. Blockchain + agricultural products circulation —— fusion path and system innovation [J]. Business Economics Research, 2021 (11): 130-133.
[10] Voulodimos A S, Patrikakis C Z, Sideridis A B, et al.A complete farm management system based on animal identification using RFID technology[J].Computers and electronics in agriculture, 2010, 70(2): 380-388.
[11] Li Xudong, Yang Qianhe, Yao Jingfa, He Ji, Fan Xiaofei. Summary of research on agricultural product traceability technology based on blockchain [J]. Agricultural Science, Jiangsu Province, 2022,50 (06): 16-24.
[12] Lin Yongmin, Lu Yinping, Zhao Dexin. Research on the application of blockchain enabling agricultural products circulation [J]. Value Engineering, 2023,42 (02): 56-58.
[13] Song Shenghong, Zhou Qin, Hu Lu, Xiong Qian, Xiao Xue. Research on the traceability problem based on blockchain [J]. Jiangsu Communications, 2022,38 (03): 54-56.
[14] Liu Jiaji, Yang Ting, Wang Wenyong. Using the dual-blockchain anti-counterfeiting traceability system [J]. Journal of Information Security, 2018,3 (03): 17-29.
[15] Li Tianming, Yan Xiang, Zhang Zengnian, Tian Yang, Wu Xin, Li Chaoqun. Research on the application of blockchain + Internet of Things in agricultural product traceability [J]. Computer Engineering and Application, 2021,57 (23): 50-60.
[16] Liu Shuangyin, Lei Moxi, Xu Longqin, Li Jingbin, Sun Chuanheng, Yang Xinting. Research on agricultural product quality and safety trusted traceability system based on blockchain [J]. Journal of Agricultural Machinery, 2022,53 (06): 327-337.
[17] Li Xuan, Liu Yi. Anti-counterfeiting traceability system based on dual-blockchain and Internet of Things technology [J]. Computer Application Research, 2020,37 (11): 3401-3405 + 3421.
[18] Ju C, Shen Z, Bao F, et al. Blockchain Traceability System in Complex Application Scenarios: Image-Based Interactive Traceability Structure[J]. Systems, 2022, 10(3): 78.
[19] Wu X Y, Fan Z P, Li G.Strategic analysis for adopting blockchain technology under supply chain competition [J].International Journal of Logistics Research and Applications, 2022: 1-24.