

# Anti-counterfeiting Traceability System for Agricultural Products Based on RFID and Blockchain

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**Abstract.** The food security issue on agricultural products has always been emerging, such as anti-counterfeiting, drug residues, heavy metal & fertilizer pollution. Agricultural products' quality & safety impacts severely upon consumers' purchase intention. To establish an entire process anti-counterfeiting traceability system, *Jingdong Farm* adopts mixing techniques, *RFID* and *blockchain*. By scanning the *RFID* tags with the *Jingdong App*, consumers can acquire the entire supply chain history of the product. The national secret algorithm embedded in the *RFID* chip and its unique *PUF* performance guarantee the products to be tracked straightly and authentically. In addition, *blockchain* makes it certain that the data within the supply chain keep from being tampered. The system will conduce to locate and recall defective products. Furthermore, it will provide e-commerce and supply chain parties with auxiliary marketing values, lower reverse loss and higher credit accretion.

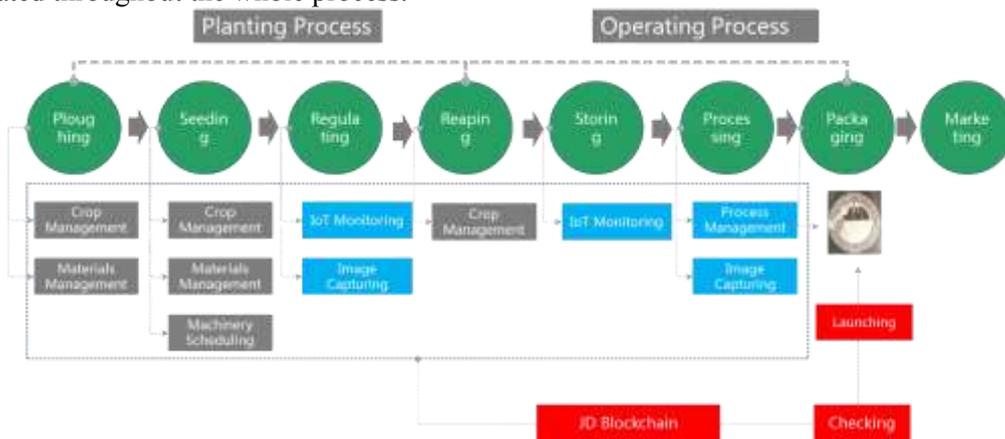
**Keywords:** RFID, blockchain, agricultural products, anti-counterfeiting, traceability.

## 1. Introduction

Since the entire life cycle of agricultural product supply chain covers planting, processing, transiting, warehousing, marketing and other aspects, the control of product quality is extremely complicated [1, 2]. It will make sense that once the whole process is scientifically supervised, the sudden or mass accidents on food safety will be avoided in advance [3]. As a decentralization-based technology [4], *blockchain* makes it transparent among transaction parties, resulting in an effective chain of sharing information and values. Once data is uploaded onto *blockchain*, it will keep from being falsified. Therefore, it is easier to locate the problem source and the real responsibilities [5]. On December 6, 2018, *blockchain* was first applied in China's agricultural products by Carrefour [6]. Afterwards, *Jingdong.com (JD)* and other e-commerce companies gradually employed the *blockchain* experiences throughout online application and offline retails. As for *JD Farm*, besides *blockchain*, *RFID* technology is also adopted with private cloud, asymmetric encryption, resulting that the brand achieves anti-counterfeiting and retrospective integration within its whole channels [7]. Thus can timely monitor the sales information at various sales points [8, 9], and also quickly track and accurately locate defective products. Furthermore, the *JD Farm* confers the system to effectively help consumers regain their confidence and re-establish trust in the agricultural products industry.

## 2. System architecture by JD Farm

*JD Farm* relies on the self-built *blockchain BaaS* platform, with the *linkchain* type of *blockchain* as the “*linker*”, combined with the experience accumulated in new technologies such as cloud computing, big data, artificial intelligence, and Internet of Things. With *RFID* and *blockchain* technology, the *BaaS* platform records important data for each piece of agricultural products, from every stage of the whole life cycle. Combined with big data processing capabilities, joint regulatory authorities, third-party agencies and brands, *JD Farm* will create a full-chain closed-loop agricultural product anti-counterfeiting traceability system. The system will ensure the complete transaction with low cost and low risk for the main participants. The transaction information can be traced and investigated throughout the whole process.

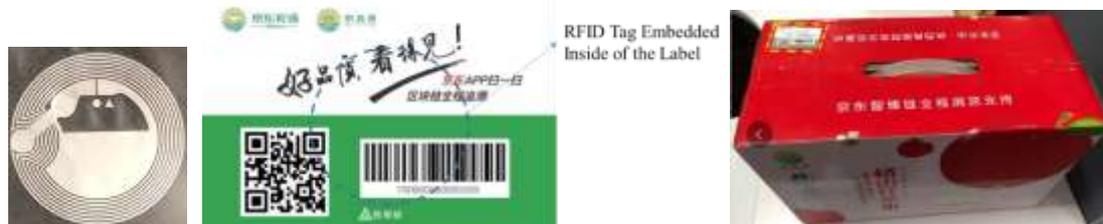


**Figure 1.** System architecture by *JD Farm*.

### 2.1. *RFID* applied in *JD Farm* system

*JD Farm Anti-Counterfeiting Traceability System* assigns a unique identity to the smallest package of each agricultural product in accordance with a unified coding mechanism, enabling consumers to verify the authenticity online. The system uses high-frequency security electronic tag chip, each chip has a unique UID, with good RF performance and compatibility, ensuring longer operating distance and more reliable read and write functions. The chip memory is divided into 64 blocks with total capacity up to 2Kbits. Built-in national commercial cryptographic algorithm *SM7* provides one-way authentication and two-way authentication, it also supports secure communication based on stream encryption. With physical unclonable function (*PUF*) [10], combined with *SM7* algorithm, the chip upgrades algorithm safety.

Figure 2 shows an example of a *RFID* tag Inlay designed for an agricultural product.



**Figure 2.** *RFID* tag inlay (left), label with tag embedded (middle), sample with the label (right).

The two-way verification *RFID* chip adopted by *JD Farm* has the following advantages:

- Reader employs hash algorithm to ensure data integrity and not tampering.
- The adopted signature algorithm ensures that a reader/writer operates the tag, keeping off impersonation, tampering and denial of reading/writing.
- Signature data includes the timestamp and the *ID* information of the current reader, ensuring of the independent and unique operation for each chip.

- Compatible with the communication protocol *ISO/IEC15693*, the tag can be read from a long distance (5~10cm) by using the handheld *NFC* module.

Different from the common *NFC* reading application, only the “*NFC sweep*” function within *JD APP* is supported, so that the anti-counterfeiting traceability information of agricultural products can be achieved. Figure 3 shows the complete traceability information obtained with *JD APP*, while Figure 4 shows the content retrieved with other *APPS*. Obviously, RFID technology highlights the anti-counterfeiting performance of the traceability system at *JD Farm*.



**Figure 3.** The Display Contents with *JD App* (Sample).



**Figure 4.** The Display Contents with Other *NFC App* for the same specimen (Sample).

### 2.2. Blockchain technology application in JD Farm system

JD Farm relies on the blockchain technology to combine the information of commodity production, processing, packaging and ex-factory with that of *Jingdong* warehouse storage, order, logistics and other information to realize the traceability of the whole product quality information.

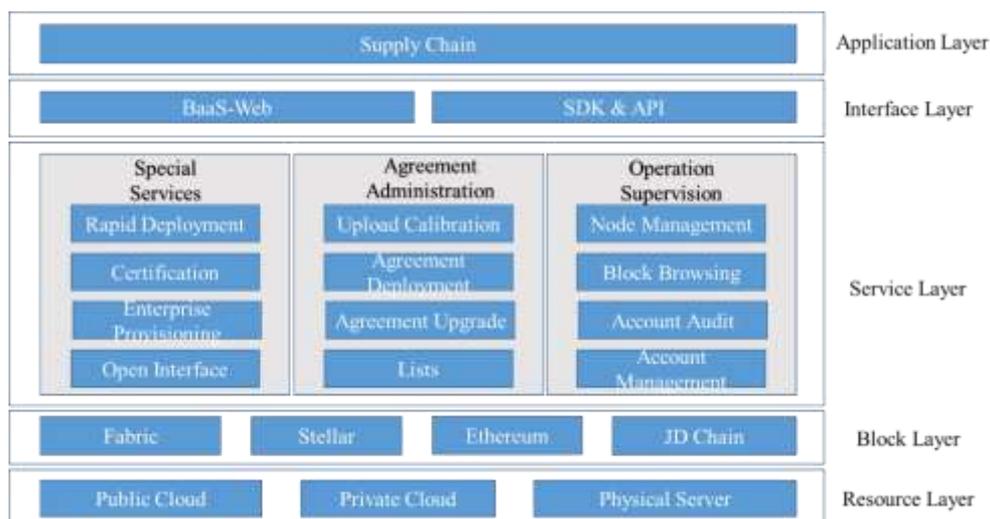
The *JD blockchain* structure is shown in Figure 5.

The *JD blockchain* has the following characteristics [11]:

- High performance
- Modular Configuration
- High security and privacy protection
- Effective data governance
- Multi-chain collaboration
- Cross-cloud networking

### 2.3. Integration of blockchain and RFID by JD farm

JD Farm provides a solution of combination of blockchain and *RFID* for its anti-counterfeiting traceability system. The system can encrypt data for agricultural products from the process of planting to sales online and offline. The entire information is encrypted and distributed, while time stamping and consensus mechanisms are added. The third-party supervision from agencies and consumers have made the production process transparent to a certain extent, and prevented the data from being tampered within any link.



**Figure 5.** Architecture of *JD Blockchain*.

## 3. Potential application of JD Farm system

### 3.1. To locate and recall problem products

With the anti-counterfeiting traceability system, the counterfeit and shoddy goods can not only be identified automatically, but the circulation records of the goods can be inquired. In the event of any product quality problems, they can be queried quickly and efficiently. Accordingly, product recalls can be made when necessary.

### 3.2. Added marketing values

The character of anti-counterfeiting for *JD Farm* system can be used as an entry point to connect users, gather consumers for brand owners, and expand sales of goods through a series of marketing promotions and promotions.

### 3.3. Data services

Providing massive professional reports, the system will result in sorting out beneficial statements for the brand parties to analyze the situations of anti-counterfeiting traceability and quantify the benefits brought by retrospective.

### 3.4. To stop reverse loss

*JD APP* calls the *NFC* function module of the smart phone to read *RFID* tag data, which can further correlate the *JD account* and order. It will benefit from blocking the technical entry of illegally access to imitate the contents in the tag. Following that, the system can recognize and track the illegal operation events. Only through this can counterfeit products be effectively excluded out of reverse warehousing.

## 4. Summary

*JD Farm* provides an anti-counterfeiting traceability system based on *blockchain* and *RFID*. It is beneficial to establish integrated network nodes throughout the whole process, from planting section, processing, logistics companies, retailers, government regulatory agencies, testing institutions to other entities. The information of each chain is stored in the *blockchain* network. After the information is uplinked, it is automatically synchronized to each node for the authenticity of the source information, thus ensuring that the recorded data cannot be falsified. It also assists the effective supervision of government departments, and transparently shares information throughout the entire process. The adoption of *RFID* anti-counterfeiting verification technology improves the efficiencies for signature and information collection, providing a more secure and effective approach. Consumers may look through the anti-counterfeiting traceability data of agricultural products with *JD App* terminal and only with the *JD App* terminal by smart phone integrated with the *NFC* module. The interests of consumers and manufacturers can be guaranteed to maximum extent with *JD Farm* system merging *blockchain* and *RFID*.

## Acknowledgement

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