

Research Article

Research on Agricultural Products Traceability Mechanism Based on RFID

^{1,3}Fuguang Bao, ²Ying Shen and ²Tongkui Gu

¹School of Business Administration,

²School of Computer Science and Information Engineering, Zhejiang Gongshang University,
Hangzhou 310018, China

³Contemporary Business and Trade Research Center of Zhejiang Gongshang University, China

Abstract: This study aim is to provide a feasible and effective way for the government supervision, agricultural enterprises and consumers to obtain traceability information. This study researches traceability of agricultural products. Through the analysis of the participators, the influence of the agricultural products circulation pattern of supply chain, traceability security system and tracing process, it constructs a pattern of the agricultural products traceability and puts forward a method to realize agricultural products traceability model. The method uses RFID to collect related information of agricultural products and realize the agricultural products traceability process based on the traceability chain construction of the agricultural products and redesigned trace code. Finally, this study analyzes the concrete application of the proposed method in beef traceability to prove the feasibility of our circulation and method.

Keywords: Beef traceability, RFID, supply chain, traceability pattern

INTRODUCTION

As the rapid advancement of the human living standard, people focus more attention on the food quality and safety (Xu, 2011). However, in the process of development, in order to improve the quantities and beautify the appearance of agriculture products, producers tend to use pesticides, chemical fertilizers, hormones, additives which not only pollute the environments we live but also do harm to human physical health significantly (Guo and Wang, 2012).

The reasons that the problematic products enter into the market is complex. On one hand, it is resulted from the diversities of green food, the intensified market competition and the complication of agricultural products. On the other hand, it is on account of the inefficient supervision (Xu *et al.*, 2009). Hence, more and more scholars are researching on the traceability of agricultural products in order to ensure the quality and safety of the products, induce the possibility of the unsafe accidents and guarantee consumer confidence.

Researches on traceability of agricultural foods and methods of traceability bring cardinal significance as follows:

- It enriches the managing theories and methods of safety and quality of agricultural foods.
- It is beneficial for government regulators to control the quality of green foods.

- It can bolster confidence of consumers and enhance a sense of responsibility of enterprises.

METHODOLOGY

Research statuses: At present, International Article Numbering Association (EAN) established the EAN•UCC (2000) system which has been accepted by 20 countries and districts to trace meats, fruits vegetables and so on (Miraglialm, 2004). EAN•UCC (2000) system includes data carrier, data exchange and encoding structure. Through Radio Frequency Identification technology (RFID) and barcode technology, we can identify and achieve data automatically, reuse network and EDI to connect data (Yang *et al.*, 2006). By using this system we can collect and record the products chain information in every single detail, so that the information can be transferred efficiently and forms a comparatively complete information chain to trace.

Yuan (2007) analyzed the traceability system primarily from quality and safety management and supply chain mode. He put forward to the overall architecture of the products supply chain traceability system. Zhou and Zhong (2006) held the view that productions properties of foods can be recorded by labels, turning consumers' trusts into observable properties, highlighting the visualization of information, in order to efficiently deliver the foods

Corresponding Author: Fuguang Bao, School of Business Administration, Zhejiang Gongshang University, Hangzhou 310018, China

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quality information between food enterprises. In 2009, the United States enacted Strengthen the food safety act of 2009, demanded Food and Drug Administration (FDA) to constitute food traceability system. By now, American products traceability system comprise of three subsystems: agricultural production, packaging and processing, transportation and sales. For each subsystem, the products information should be recorded and regulated by the food supply traceability system, product recall system, HACCP authentication (Xing, 2006). Holland has a developed traceability system, especially pork traceability system which can control the whole chain involved the feeding, slaughter, processing, selling (Chen *et al.*, 2007). In 1996, European Union (EU) had already started researches on traceability of agricultural products and gained stable implements in several areas. This research had improved the safety of products and played a positive role in manufacturing of animal by-product (Yu, 2011).

In terms of establishment and implement of traceability system, Shanghai livestock sector had set up the immune identification for pigs, cattle, sheep and other livestock to guarantee the traceability animal by-products. The identification includes ear tag and immune book. By the Identifying codes, consumers can query the information of products bought in Shanghai agricultural websites (Wang *et al.*, 2008). Hainan tropical fruit quality tracking system which is led by governments has finished and started operating. This system records the whole process of information in the supply chain, includes planting, manufacturing, packaging, transportation, selling etc. Consumers can input the traceability codes and check out provided information such as the origin, nutritional ingredient, life cycles, etc., (Meng, 2010).

Difficulties in traceability: Because of the intensive market competition, the study of Agricultural Products Supply Chain (APSC) covers the whole process involved the top of the supply chain and products circulation. Although we have studied more details than before about the products supply chain, we still cannot exactly figure out its operational modes. The reasons are as follows.

Complexity of participants and structure: APSC involves quite many subsystems and participants, appears different characteristics and structures in manufacturing, processing, selling, circulation and other steps. Besides, APSC involves various domains, has dynamic notes in the chain which increase the complexity of managements. In the meanwhile, decentralized production and low-level informatization also increase the complexity of APSC.

Instability: There exists a certain degree of instability in APSC and the reasons are various: the changeable natural environments will affect the planting and

circulation of products; the range of purchasing is limited for the specific area of green food; the owners of farms mostly are farmers who are not well-organized and partly blind to the market; multiple steps and low-level informatization result in the widely existence of information distortion in APSC.

High transaction costs: Most farmers run small-scale productions and haven't mastered advanced technologies, which leads to non-uniform quality, low-level standardization and weak in profit. Frequent fluctuations of prices and diverse demands make it easier for both sides of contract break the contract and increase the cost of default. Moreover, regulatory difficulties increased because of multiple detections and verifications, wide and various domains, which in turns increase the costs.

Single driven factors: In APSC, manufacture, circulation, management and other steps depend on consumer demands. In other words, the changes of consumer demands will affect each step in the supply chain.

APSC traceability model: In his part, we constructs agricultural traceability model in four aspects: APSC circulation pattern, main participants, Traceability regulation system and detailed process.

Main participants in traceability: In our model, there are three main participants in the implement of agricultural products traceability: government, consumers and food enterprises.

Government plays a supervision and management role in the process of traceability and enacts relative laws and rules to ensure and encourage the process. Once problems occur, regulators can find out where the problematic products have gone, where the products are from, which participants should be blame, why this kind of problem would happen.

Consumers are beneficial from the traceability system. Consumers can query the information provided through the traceability code to decide whether to buy the products or not. The roles consumers play in the traceability system are the receivers and responders.

Agricultural products enterprises involve manufacture, processing, circulation and selling which are in the same chain. Agricultural products enterprises can improve the level of quality control and reduce enterprise management costs through traceability. Hence, enterprises are information providers of produce, as a turn, they are beneficiary from traceability for quality control.

How supply chain pattern affects traceability: Nowadays, the circulation patterns of produces are complex, not all the circulation patterns can realize the

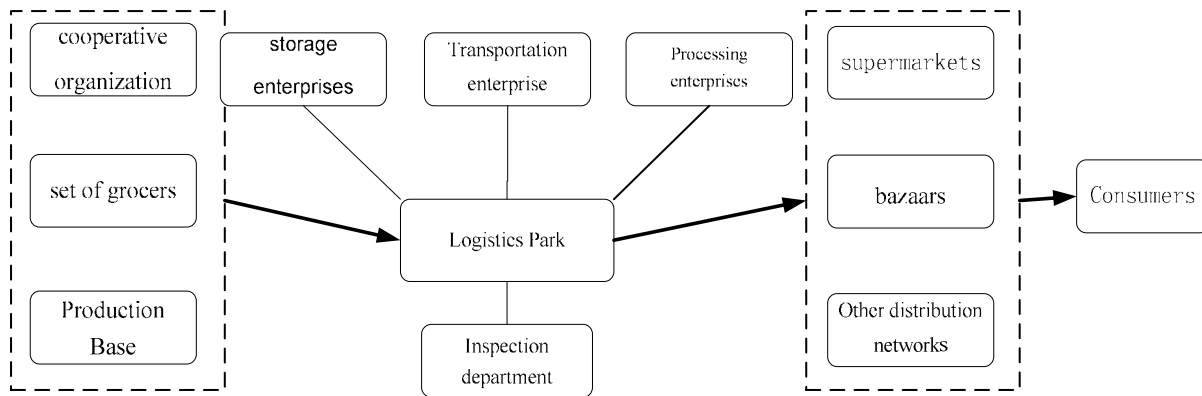


Fig. 1: The circulation pattern that as the Core of Logistics Park (CLP)

whole process trace of produce. So, it's crucial to choose a proper circulation pattern to prevent waste of resource and inefficiency. This chapter analyses three developing and long-term used circulation patterns (as the core of wholesale market, as the core of supermarkets and other retail shops, as the core of logistics parks) in China and comes to conclusion how circulation patterns affect traceability.

The circulation pattern that as the Core of Wholesale Market (CWM): In China, wholesale market undertakes near 70% agricultural products in circulation. Although it seems large number of shares, there are still many problems. Beside the multiple steps and long distance, the management of wholesale market is irregular, laggard informatization construction, isolated merchants and other drawbacks. Nevertheless, through improving the logistics system and enacting modern enterprise system, wholesale market can realize the transformation.

The circulation pattern that as the Core of Supermarkets and other Retail shops (CSR): In this pattern, upstream and downstream of APSC forms a unified whole. This pattern is the modern circulation pattern of agricultural products. Dominant retail shops and definite supply and demand of produces make logistics controllable and cooperated. The general characteristic of this pattern is mature logistics system, a high degree of informatization, stable market demand, safe and reliable quality, simple steps and efficient. It can record and control the food information for the rigid controlled steps and high degree of informatization. Long-term and stable cooperative relationship benefits both supermarkets and farmers.

The circulation pattern that as the Core of Logistics Park (CLP): Now, some metropolises are gradually constructing logistics centers or logistics parks of produces to make up the a function of market, enhance the management of supply chain and rigidly control the

produce quality. This pattern connects farmers, farmlands and other intermediary organization and forms an integrated circulation pattern includes manufacture, purchase, processing, storage, insurance, sales and distribution and information provider. The basic structure is shown in Fig. 1.

As you can see from Fig. 1, Logistics Park can have a reasonable planning by using the integrated effect for the wholesale market, distribution center, processing center, testing center and information system. Logistics Park focuses on integrated, large-scaled and informational produce circulation mode. Its basic function can be summarized as "Storage, Connection and Distribution". Storage is to set up cold storage and warehousing center in Logistics Park and enhance the preservation storage of agricultural products. Connection means connecting the producer (farmers, farmlands, etc.) and demander (wholesalers, supermarkets, shops, etc.). Connection can realize agricultural products integration of supply and marketing, speed up the circulation. Distribution, which implements bidirectional deliver for agricultural products, technology and information.

After realize three circulation pattern mentioned above, we can conclude that the main factors of affecting traceability implementation are as follow:

- Whether agricultural planting and breeding are large-scaled, the source is clear.
- The integration of supply chain, the tightness between each step, the definition and suppleness of the intermediate steps.
- Whether sales records of agricultural products are true and reliable, whether identification effects are observable.

Analysis of tracing process: In order to realize agricultural products traceability, first need to understand the basis of the traceability which means the acquisition of agricultural products information. The information include: information identification and collection, information processing, uploading,

information integration. Information identification and collection need rapid and accurate collection of produces data. Information processing need to ensure the information updated timely. Information integration mainly integrates produces information of various enterprises, form a complete information chain and carry on the whole process according to the flow of agricultural products. The tracing process includes the track of positive and reverse traceability of agricultural

products. Traceability can be realized according to enterprise records of identity information and batch numbers in the circulation steps (loading and unloading). Positive tracing is mainly used to identify the flow of the same batch of agricultural products. Reverse tracing mainly identify source of agricultural products. After positive and reverse tracing, we can fully control agricultural products flow and diffusion. Figure 2 shows the tracking and traceability of

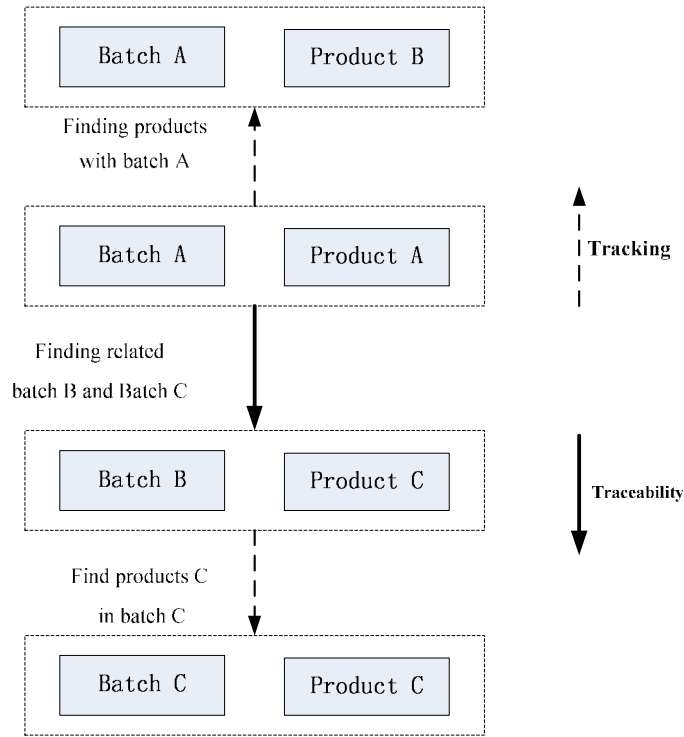


Fig. 2: Traceability process

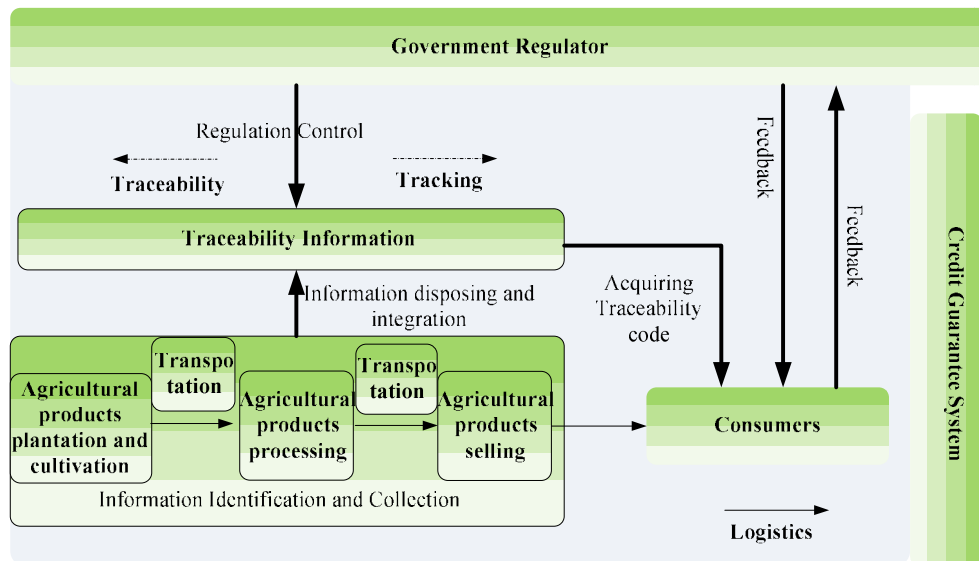


Fig. 3: General traceability model of agricultural products

problematic batch A, illustrates the tracing process. Through the detection of agricultural products and enterprises, records of traceability, as well as the specific problematic agricultural products, regulators can enact relevant laws and rules. In addition, the tracing results should be timely feedback to customers.

Construction of tracing pattern: Through analyzing of the influence elements of traceability, this chapter puts forward the pattern of produce traceability to describe the composition of produce traceability, as shown in Fig. 3. This pattern shows the composition, flow and main body status of traceability, can better describe the main process of agricultural products traceability.

Our traceability pattern has three participants: produces enterprises, government, consumers. Government mainly manages agricultural products traceability information. Customers obtain traceability information and timely feedback problematic produces to the relevant government department. Agricultural enterprises mainly provide complete information in the process of circulation of agricultural products. Agricultural products traceability is based on the complete information, so you need to choose typical circulation pattern of application. On this basis, we can effectively track and trace problematic produces using specific data collection methods and the traceability principle.

APPLICATION OF BEEF TRACEABILITY

Analysis of beef supply chain: Generally speaking, there are two main types of final form of the beef products directly provide consumers with raw beeves and make cooked-beef eaten by consumers directly. The second form is more complicated than the first one and it is the extension of the first form. This chapter analyzes the first form and its overall supply chain structure shown in Fig. 4:

- **Beef rearing:** Generally, beef rearing is divided into several categories: free-range by farmers, reared by specialized households and raised in special base. For free-range by farmers, the quantity of cattle is limited, the health of the cattle can't be guaranteed, it is easy to infectious diseases and farmers may use hormone to promote the growth of cattle. For specialized households, they prefer managing large-scale farming mainly for the purpose of making profits. For base breeding, they raise cattle in a larger scales, the quantity can reach tens of thousands.
- **Slaughter and rough machining:** In this section, the main processes are perm hair, shave, broken skin, viscera, wash and cut into carcass, quarantine. This section is the core of beef quality supervision. General cattle need to be sent to designated processing factory for slaughter, related product information should be recorded, beef quality should be guaranteed. In reality, there exist many places for slaughter and without a complete regulation and control, which brings healthy problems.
- **Storage and transportation:** Beef need to control the temperature to suit different beef products in the circulation and storage. Most beeves are directly selling to consumers after slaughter, which is easy to infect bacteria and harmful to people's health.
- **Sales:** The objects of sales are different according to different beeves. In the traditional supply chain, the products mainly are sold to customers through supermarkets, wholesale markets. Whereas, in the new supply chain, raw beef tend to have a cooperation agreement, the products are sent to the specific objects, such as supermarkets, hotels.

According to the analysis of beef circulation pattern, realizing the whole process of supply chain traceability management is a new circulation pattern, or

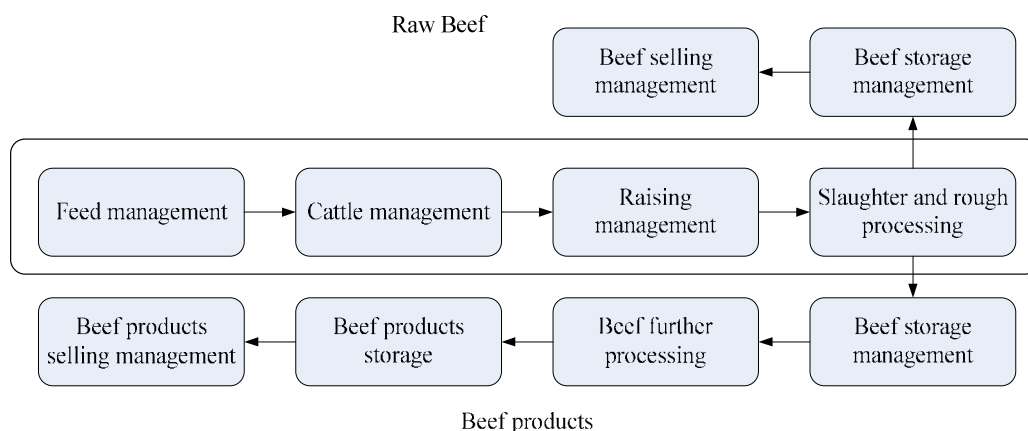


Fig. 4: Beef supply chain structure

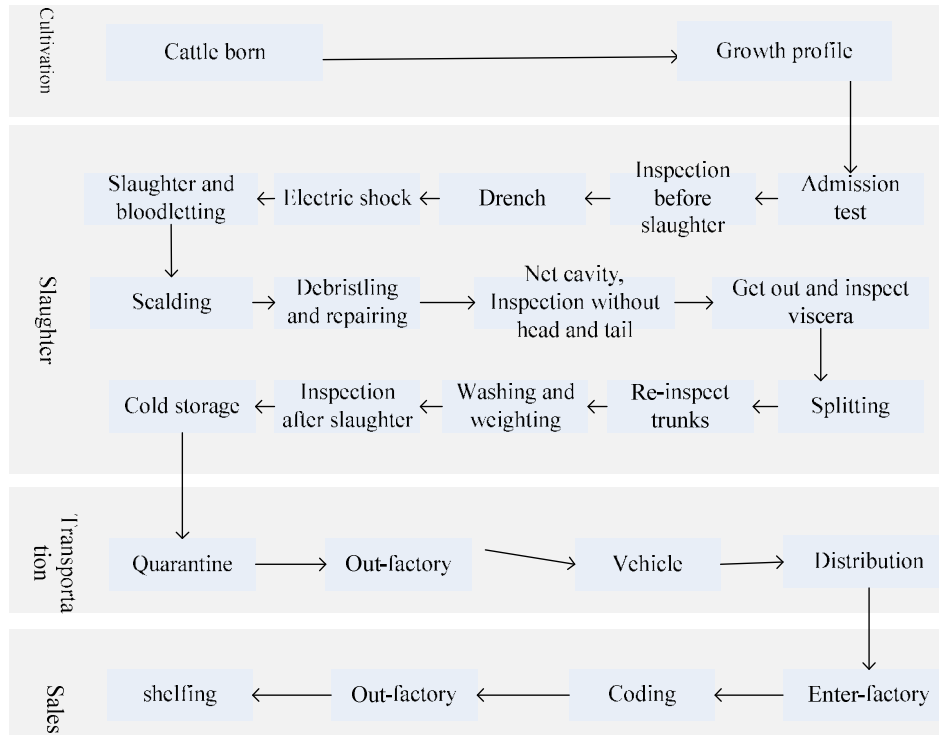


Fig. 5: Beef supply chain business processes

is a mixture pattern of mastering cattle retail information to circulation. Therefore, the following analysis on the beef products traceability is mainly focusing on the new circulation pattern of supply chain, the node enterprises are breeding base, slaughter factories, supermarkets.

Analysis of beef traceability information: In the process of the implementation of traceability management, the core parts are efficient and accurate data acquisition and recording the traceability information. Firstly we should analyze business process to the whole supply chain, as shown in Fig. 5 and then analyze the information needed.

After sorting out related business process, we need to clarify what information is needed, what information can be used to trace. It is not possible to record every data, because it not only increases the burden of system, but also increase the difficulties of enacting standards for data collection. Therefore, we should consider factors relatively. In this study, we choose of traceability information based on the RFID in the supply chain, the principles are:

- Record information reflects the basic conditions of each enterprise.
- Record information that may create a safety problem.
- Record information countries and related organizations enforce to.

Implementation of traces: After determining the circulation pattern and business process of beef products, we can establish beef specific traceability pattern of agricultural products on the basis of the basic form of tracing pattern in the third chapter and the fusion with specific trace method, as shown in Fig. 6.

It is known from the analysis of the business process that, beef products has its own characteristic and RFID tags will continue to follow cattle after slaughter. That is to say, in the processing, individual identification numbers are same from cattle, beef products and selling. Therefore, you can trace according to the relationship between beef products in the process of circulation of the whole batch and identity number. If beef products are found in selling having quality problems, traceability of the specific process is as follows:

- Depends on the tag number of these multiple beef products, you can identify the final sales to other beef products respectively belonged to same cattle, at the same time determine the breeding base, slaughterhouses and supermarkets according to identity number of agricultural products. Among them, each identity number can exclusively determine breeding base, slaughterhouses, because identity tag is a unique identifier of cattle before slaughter.
- According to identity number to determine the number in each step of other beef products and the

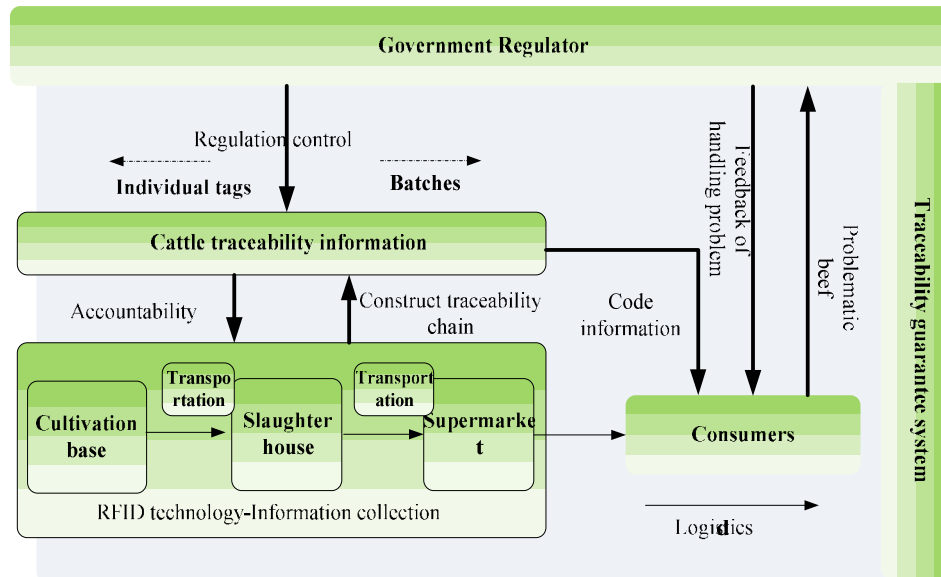


Fig. 6: Beef products traceability pattern

final seller. Based on the trust level of certain agricultural products enterprises, detect those enterprises and analyze the causes in batches from the low credibility of beef breeding base, slaughterhouses and supermarkets using the collected traceability information. If you can get the conclusion and find the problematic step of beef product, then continue to set out from the step in the batch and to track and trace of beef batches before and after, to find all the problematic beef products.

CONCLUSION

This study analyze participators, circulation pattern influence, the process of traces, has constructed the agricultural products traceability pattern, use the batch number and design traceability code implements the tracing process. For analyzing participators in agricultural products traceability, we determine its characteristics and roles in the agricultural products traceability. For analyzing supply chain circulation pattern, we determine the applicable object of agricultural products traceability, provide the foundation for traceability implementation environment, analyze agricultural products traceability process and determine the basic requirements for implementation traceability. Comprehensive above analysis, we build agricultural products traceability pattern, show the basic framework of the agricultural products traceability and provide feasible reference for agricultural products traceability. This study concretely studies specific information collection of RFID in agricultural products supply chain, construct agricultural products traceability chain based on the

batch number and codes for consumer traceability, provide a feasible and effective way for the government supervision, agricultural enterprises and consumers to obtain traceability information.

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