A Comparative Study on Tracking and Traceability System of Meat Supply Chain

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Abstract: Meat is a good source of nutrients, and meat supply chain plays a paramount role in everyday life. Due to recent food crises (e.g. BSE, and hand-foot-and-mouth disease) in the world, food safety and quality control have become a hot topic in mass media, especially the meat products. This paper first relies on extensive literature to describe the tracking and traceability system of meat supply chain used in the United States from three aspects – supply chain mode, tracking and tracing technology, and management mechanism. Then for the purpose of comparison, the Chinese version of the tracking and traceability system is presented from the same aspects. Finally, improved suggestions for China's meat supply chain management are presented.

Key words: tracking and traceability system; meat supply chain; food safety; quality control

1. Introduction

Over the past twenty years, the world has grown increasingly concerned about the threat food safety pose to the societies. Meat is a paramount part of healthy diet, which is an excellent source of quality protein. And it has attracted more and more attention of the masses on its safety. A number of disastrous events have been witnessed in the past by the world, for example, the BSE (bovine spongiform encephalopathy or "mad cow disease") broke out in the United Kingdom, hand-foot-and-mouth disease burst out in many countries, and international recall of Italian sausage products recently. It is now generally agreed that a large-scale food safety events can conceivably cause a huge economic losses, and drastically destroy local or regional social system.

These food safety events, especially meat products, impose a great challenge to public health system, and thus improving the ability to handle these emergencies has become an urgent issue. Tracking and traceability system is one of the solutions to recall these unsafe food products. And businesses, consumers and authorities around the world have an interest in establishing systems to track and trace meat products at various points of the supply chain. ISO (International Organization for Standardization), which develops voluntary international standards for products and services, defines traceability as the "ability to trace

the history, application, or location of that which is under consideration."[1] Although this definition is quite broad, and not specifies a standard measurement for "that which is under consideration", tracking and traceability systems are believed to bring many benefits to all these stakeholders. For meat supply chain, tracking and traceability systems are a tool to help firms manage the flow of input and products to improve efficiency, product differentiation, food safety, and product quality.

Tracking and traceability systems of meat supply chain are record keeping procedures, or tracing systems, that record the path of meat products from its initial supplier through all processing stages until reach the end consumer. A tracking and traceability system allows the meat industry to:

- ✧ Promptly locate and remove unsafe meat products in case of a recall: record keeping procedures are helpful to find out the location of unsafe products.
- ✧ Protect brand reputation: keeping precise records allows companies to quickly identify and recall only unsafe meat products, reducing the scope of a recall, demonstrating good corporate citizenship and a high level of concern for public health, therefore limiting negative media exposure and perhaps even turning it positive.
- ✧ Diagnose problems in production and determine liability where relevant: traceability can help resolve process problems and determine third-party responsibility if records show that an ingredient supplier or co-packer was the source of the recall ingredient. Although the manufacture of the final product is still responsible for the recall, complete records tracing ingredient to their sources may allow seeking indemnification from responsible third parties.
- ✧ Develop the international markets: while many countries establish strict food market access mechanism, especially USA, Canada, EU and Japan, food companies possessing tracking and traceability systems can easily enter these markets.

The United States and China are the representatives of developed and developing countries separately. And they are also the largest meat products producers and consumers in the world. Since the two countries have displayed different meat supply chain operation and management, it will be necessary and valuable to understand the country-specify tracking and traceability system for managing meat supply chain. Hence, the objective of this paper is threefold. First of all, we review the tracking and traceability system of meat supply chain used in the United States and China from tree perspectives: supply chain mode, tracking and tracing technology, and management mechanism. Second, we summarize the similarities and differences of the two countries' tracking and

traceability system. Finally, improved suggestions for China's meat supply chain management are presented, and a number of research problems regarding the tracking and traceability system of meat supply chain that deserve attention and further research are identified.

2. Analysis of America's Tracking and Traceability System

2.1 The supply chain mode

As a developed country, the United States has a high level of urbanization. With the concentration of population in the cities, supermarkets play an important role in meat supply chain. Figure 1 shows the main supply chain mode, taking beef for example. [2]

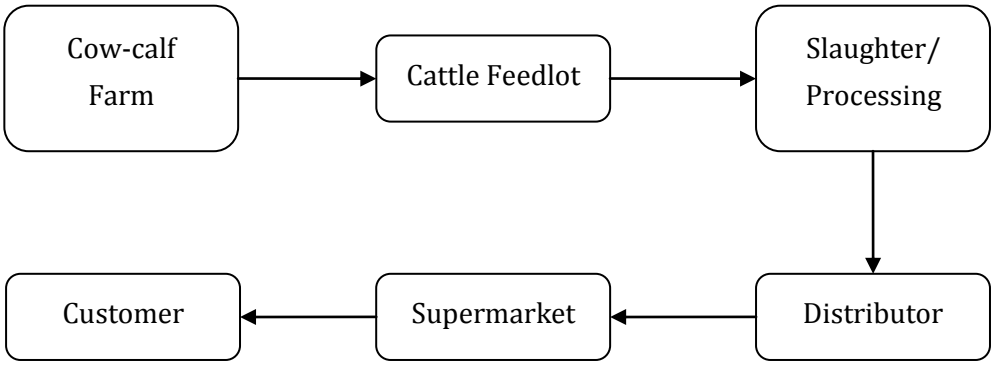

Figure.1 Beef supply Chain

In the United States, there are five important key nodes, including cow-calf farm, cattle feedlot, slaughter/processing, distributor, and supermarket. Most of the beef that Americans consume originates from cattle born and raised on one of the country's 800,000 cow-calf farms, with lesser amounts coming from U.S. dairy (culled dairy cows) and from Mexico and Canada. At 6 to 18 months old and weighing 500 to 900 pounds, calves are moved to a cattle feeding operation. Cattle feeding operations, or feedlots, are enterprises largely unique to the United States. And feedlots are of two major types: farmer feedlots and commercial feedlots, with the latter gaining greatly in dominance over the last three decades. While cattle matured, they will be transferred to slaughter plants and processors. There are over 3000 small and large firms slaughtering or processing cattle in the United States. Most large firms convert beef carcasses into primal and sub-primal cuts or "boxed beef". After that, these beef products will be distributed to supermarkets by distribution center. And then, customers can buy beef products in these supermarkets around the country.

2.2 The tracking and tracing technology

The tracking and traceability system of meat supply chain can be divided into two parts, from farm to slaughtering plants and from slaughtering plants to consumers. In the first part, tracking and tracing objective is the living animal, and the latter is the meat product. Different technologies are applied in the two parts.

The traditional method of identification for livestock is branding, whether hot branding, freeze branding, hide branding, or horn branding. Other methods of animal identification include tattooing, retina scanning, iris imaging, DNA fingerprinting, autoimmune antibody matching, nose print matching, facial recognition, and currently the most common method, tagging (in the ear or around the tail, plastic or metal, button or dangle, plain or RFID)[3]. With these animal identification technologies, livestock not only can protect their property from theft or loss, but also can control the spread of animal diseases.

After livestock is slaughtered or processed, the tracking and tracing work is mainly relied on product package. In accordance with ISO 9000 guidelines, most track information is collected by batch or lot and then assign new batch or lot numbers to track product as it is transformed. The information includes source, data in produce, quarantine information before and after slaughtering.

Moreover, information system is essential to tracking and traceability system. And all these information collected from the two parts, from farm to slaughtering plants and form slaughtering plants to consumers, should be storage in the information system. RFID is a kind of convenience tool to the tracking and traceability information system of meat supply chain.

2.3 The management mechanism

In the United States, the management mechanism of tracking and traceability system in meat supply chain can be divided into three layers, including animal ID (identification) system, sample testing in production process, and laws and regulations. USDA (United States Department of Agriculture) and FDA (Food and Drug Administration) take responsibility for the tracking and traceability system.

Work toward a coordinated national animal ID system began in earnest in the early 2000s with the formation of the National Food Animal Identification Task Force, facilitated by the National Institute for Animal Agriculture (NIAA). And following the first U.S. report of a cow with BSE in late December 2003, USDA took the lead in implementing an animal ID program capable of identifying all animal of interest within 48 hours of a disease discovery.

HACCP is a technical management system to ensure food safety, and sample testing is an important part. If meat product failed the test, it can’t move into the next segment of the meat supply chain. Furthermore, FSIS (Food Safety and Inspection Service) regulations require that slaughter plants keep the head and

certain organs of slaughtered animals, plus all identifying tags, until all parts of the animal pass inspection.

There are many laws, regulations, directives, notices and policy decisions enable tracking and traceability system to protect public health. For example Bill H.R. 1254, H.R. 1256, and H.R. 3170 concern the animal ID system. As a whole, the United States has formed a perfect law and regulation on meat products safety and quality control, with regard to animal raising, slaughtering, distribution, marketing and recalling.

3. Analysis of China's Tracking and Traceability System

3.1 The supply chain mode

As a developing country, China has a low level of urbanization. The countryside is a huge consumer market as the cities, for there are more than 700 million rural populations, in contrast with 560 million urban populations. Therefore, there are two different type meat supply chain mode. One severs urban residents, and the other is for country dwellers.

Similar to the United States, supermarket plays a paramount role in the meat supply chain in urban market. And Farmer's market is also an important place where exchange of meat products takes place. Figure 2(a) shows the main meat supply chain mode in urban market.

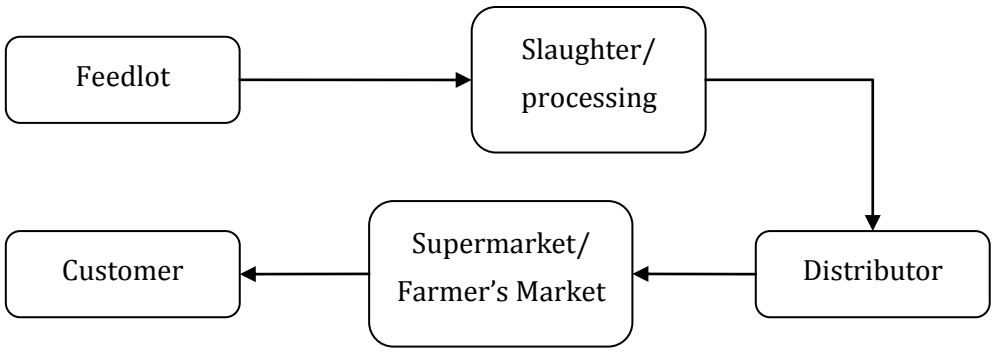

Figure.2 (a) Meat supply chain for urban residents

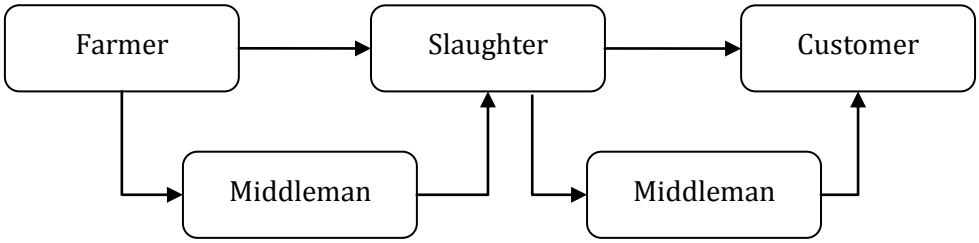

Figure.2 (b) Meat supply chain for country dweller

Compared with supply chain mode in urban market, the meat supply chain in rural market is more complex. In urban market, meat products sales work is

usually done by self-employed worker, while livestock is raised by farmer in small scale. Self-employed worker not only can buy livestock from farmers, but also from middleman. Figure 2 (b) shows the meat supply chain mode of rural market. In this mode, there are usually exiting multi-agent middleman.

3.2 The tracking and tracing technology

In order to tracking the raising, slaughtering, transportation, and sell segments, Ministry of Agriculture launched a program to identification livestock. Now the main technology used in ID system is ear tag, and the corresponding record. Some provinces have begun to use RFID to identification livestock in large feedlot [4, 5].

While meat products produced, tracking and traceability work is relied on product package. In addition, there are also some biometric technology can be employed to tracking and tracing meat products. The Chinese Academy of Agriculture Science has developed a tracing technology using beef stable isotopes. Moreover, information system is essential in Chinese meat tracking and tracing system.

3.3 The management mechanism

In 2009, China introduced a law ("The PRC Food Safety Law") protecting food safety. And later in 2010, Food Safety Commission have established in response to a series of embarrassing scandals involving tainted food products, and the leader is vice Premier Li. Chinese Ministry of Agriculture, Chinese Food and Drug Administration and General Administration of Quality Supervision, Inspection and Quarantine are the main departments taking responsibility for the tracking and traceability system.

In meat supply chain, HACCP and GMP are the main operation specifications [8]. Therefore, sample testing is an important mean to ensure food safety. Only passing the test, meat products can be sold in the market. And aperiodically, the market management carries out sample inspection.

Except the PRC Food Safety Law, there are also other laws, regulations, directives, notices and policy decisions concerning tracking and traceability system. For example, the recall provision of food lays down in detail for the scope of assessment, recall, and responsibility, which is made by General Administration of Quality Supervision.

4. The Comparisons

The preceding two sections provide detailed description of the three critical aspects of tracking and traceability system of meat supply chain in the United States and China. The definition of tracking and traceability is necessarily broad because it is a tool for achieving a number of different objectives. Judging from

the current situation, complete tracking and traceability of meat supply chain is impossible, and there exist some differences between the United States and China. Here we compare them from two dimensionalities, breadth and depth.

4.1 Breadth comparison

Breadth describes the amount of information the tracking and traceability system records. Depending on the level of meat supply chain, the breadth of tracking and traceability system is different between USA and China. Table 1 shows the differences.

Table 1. Breadth differences between USA and China

	The United States	China
Traceability at the feedlot/ Farm	National ID system is in progress, and feed traceability has done.	ID system is in progress by various provinces, and feed traceability is still blank.
Traceability from feedlot to slaughter	Traceability information linking the transaction is recorded.	Large firms record the transaction information, but in rural market it is blank.
Traceability at slaughter	Head and certain organs of slaughtered animals are kept, necessary information is recorded.	In large firms, necessary information is recorded, but in rural market it should be enhanced.
Traceability for meat	Product package keeps the information.	Meat sold by supermarket can be traced, and other is out of control.
Linking animal and meat products	Have begun to bridge animal and meat products.	Blank.

4.2 Depth comparison

The depth of a tracking and traceability system is how far back or forward the system tracks. In many case, the depth of a system is largely determined by its breadth: once the firm or regulator has decided which attributes are worth tracking, the depth of the system is essentially determined.

As a whole, the tracking and traceability system of meat supply chain in the United States is deeper than China. And the depth difference concrete reflection

in information collection and documentations of tracking and traceability system.

Information is fundamental for tracking and tracing. Unlike China, tracking and traceability system in the United States collect much more information, which can assure basic system function of smoothly progress. Documentation is also important to tracking and traceability system. In USA, detailed documentations are required to record the operation process, especially the key points of the meat supply chain. Furthermore, laws and regulations related with meat tracking and traceability system usually provide documentations for details. And in China, these documentations are lack of attention, so that laws, regulations and provisions are difficult to be executed.

5. Concluding Remarks

A comparative study on tracking and traceability system of meat supply chain between the United States and China has been proposed. And the successful experience of USA in meat tracking and tracing is more worthy of study for China, despite the difference of fundamental realities of the countries. First, the national animal ID system should be brought into operation. Second, expand the extent or range of information collection for tracking and traceability system. Third, enhance documentations management.

Although the tracking and traceability system can bring benefit to all these stakeholders in meat supply chain, a number of research problems deserve attention and further research. One of the problems is that whether tracking and traceability system be mandatory or voluntary [7]. The second problem is the necessity of linking animal and meat products. And the third one is how to improve the efficiency of tracking and traceability system.

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