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Study on Causes of Slow Progress in Promoting the Application of Food Traceability System in China

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Abstract Chinese government has attempted to promote food traceability system with all strength, but the application process of this system is very slow. The reason is that the adopters have a low level of system application, which causes the system to be invalid at the source of traceability. This paper applies literature research method to analyze the influencing factors for slow application process of the food traceability system in China from various angles including manufacturer, technology, consumer and law, and further concludes that the applying intention of manufacturers, cognizing and purchasing intentions of consumers, and legal environment are important factors for slow progress of system application. On the basis of the research conclusions, the paper proposes practical ways for better construction of food traceability system in China.

Key words Food traceability system, Application progress, Literature research

1 Introduction

In recent years, various kinds of food safety incidents occur frequently, such as the "Sudan Red" incident, "Melamine" incident, "Crawfish" incident, *etc.* The occurrence of a series of food safety problems has caused serious damages to the lives and health of consumers. Moreover, consumers now are extremely worried about domestic food quality and safety. Therefore, improving the management level over domestic food quality and safety is a task which brooks no delay. And in order to improve the management level in this field, the government has attempted to build a food traceability system from the turn of the century. In 2001, Shanghai Municipal Government took the lead to promulgate the *Interim Measures for Safety Supervision of Edible Agricultural Products in Shanghai*, which requires the production bases of agricultural products to record the use of pesticides, fertilizers, veterinary drugs, feed stuff and feed additives during the production process of agricultural products as well as the epidemic prevention and quarantine inspection conditions so as to ensure the quality traceability of agricultural products. In 2002, Beijing Municipal Government promulgated the food information traceability system, which requires food traders to keep a detailed record of the producing area, supplier, purchasing date and batch number of the food for sale. In 2005, a number of provinces and cities including Beijing, Tianjin, Shanghai and Fujian launched the construction of traceability system for agricultural products intensively. Since 2010, the Ministry of Commerce of China has started to launch the pilot project of "One meat and one vegetable" traceability system in 35 large and medium-sized cities successively. Through the construction for over 10 years, the overall progress of China's food tracea-

bility system is quite slow with a relatively low proportion of benefited cities and population. That is why it is extremely urgent to find the causes for slow application process of food traceability system in China.

2 Analysis framework

The author will analyze the causes for slow progress in building the food traceability system from the perspective of food makers. As rational-economic men, manufacturers will make decisions on food quality and safety and the combination of related inputs according to the principle of minimizing risk cost or maximizing risk return on the premise that their own interests and operation safety are ensured. The key to the application of the food traceability system, as one of the management mechanisms for food quality and safety, by food makers lies in whether it will help to increase the expected premium or reduce risk losses. As a result, the acting mechanism for manufacturers to apply the food traceability system is attributed to the income level of them eventually.

The research on food makers should be carried out through the comprehensive analysis on the decisions of manufacturers for applying the food traceability system at two levels, the inside and outside the manufacturers. The former includes the applying intention of food makers, while the later includes technical means, cognizing and purchasing intention of consumers and domestic legal environment.

On the basis of previous research conclusions as the argument for discussion, the author applies literature research method to check if the above factors will exert an influence on the interests of manufacturers after applying the food traceability system, analyze whether the above factors are critical factors that influence the manufacturers' application of food traceability system, and further determine whether the above factors are the main causes for the slow application process of food traceability system in China.

Received: March 20, 2014 Accepted: April 29, 2014

Supported by the Humanities and Social Sciences Planning Project of Ministry of Education (11YJA790039).

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3 Application of food traceability system by manufacturers

As the main body of supplies for safe food, the manufacturers bear inescapable responsibilities for food quality and safety. And as the adopter of food traceability system, the manufacturers' cognition and application degree of this system is an important factor to speed up the application of this system. In the food supply chain, the term "manufacturers" is a broad concept that includes peasant households and food enterprises. As essential difference exists between peasant households and food enterprises, it is certain that there will be many differences in the cognition and application of traceability system between the two sides. As a result, the application situation is also different between the two sides.

3.1 Present situation of application by peasant households

Peasant households are producers of edible agricultural products and the ultimate source of food traceability information. The cognizing and applying intention of peasant households on food traceability system is an important factor that determines whether the food traceability system can be applied in food source.

Zhou Jiehong and Jiang Liqing investigated the intention and behaviors of 302 vegetable-growing households in Zhejiang Province to participate in the traceability system, and the results show that the households have a weak willingness to participate in the traceability system and have a low participation ratio^[1]. Xu Lingling, Shan Lijie and Wu Linhai investigated 263 apple growers in Fengxian County of Jiangsu Province on their participation behaviors in the traceability system. And the results show that only 22% of the growers participated in the traceability system of agricultural products^[2]. Wang Huimin and Qiao Juan studied the behaviors and benefits for peasant households to participate in the food traceability system, and the results show that 72.7% of the peasant households participate in the traceability system with the promotion of the government and industrial organizations^[3]. Taking the pear planting industry in Portugal for example, Monteiro and Caswellb *et al.* have elaborated that food traceability system is an essential condition to get into the international market including the European Union^[4]. Besides, through the analysis on the strawberry planting industry in California of the United States and the melon planting industry in Rome, Pouliot and Sumner believe that although the construction of traceability system has reduced the expected revenue of farmer households, the tracing and recall system for defective products with clear lines of responsibility will help to protect the interests of some farmer households. Thus, the farmer households are willing to participate in the traceability system by sacrificing partial profit^[5].

3.2 Present situation of application by enterprises The biggest difference between food enterprises and peasant households is that food enterprises have sound management systems and business objectives as well as advanced management means for food quality and safety. Therefore, the present situation of food enterprises in cognizing and applying the traceability system has a direct impact on traceability information that can be obtained by consumers.

The research of Yang Qihong and Wu Xiumin on 61 producing and processing enterprises of agricultural products in Sichuan Province shows that 83.7% of the enterprises deem the construction of traceability system as a high risk and 83.6% of them think that the cost is high. In the second place, the enterprises have estimated a lower payment intention of consumers, and only 19.67% of the enterprises are willing to build the traceability system^[6]. The research of Zhou Jiehong, Wang Yuan and Zhang Shi *et al.* indicates that the number of vegetable suppliers applying the vegetable traceability system only accounts for a low percentage due to a lack of understanding about the traceability system^[7]. Shan Lijie, Wu Linhai and Xu Lingling *et al.* have made an investigation into 200 food enterprises in Zhengzhou, Henan Province on their investment willingness and investment level in the traceability system, and the results show that 76.4% of the enterprises believe that the traceability system will help to increase sales. As a result, 79.2% of the enterprises are willing to invest in the traceability system, but 80.7% of them have chosen the investment level of lower than 20% of the new investment^[8]. Resende – Filho *et al.* have evaluated the economic value of the beef traceability system by using the principal-agent model, which indicates that the key function of the traceability system lies in that it will help to reduce information asymmetry in the food supply chain and distribute the benefits obtained among enterprises in a better way^[9]. Taking the meat supply network in Italy for example, Banterle and Stranieri believe that the traceability system helps to redistribute the responsibilities of meat suppliers and strengthen the bond between the upstream and downstream of meat supply chain^[10]. The above authors have further investigated 146 food producing enterprises in Italy, and 76% of them have applied the food traceability system to ensure product quality and safety^[11]. Taking 871 agricultural enterprises as samples, Danielle Galliano and Luis Orozco have proved that the complexity of business organizations and the construction of information system in enterprises have played a vital role in the traceability system^[12]. Moreover, Matthias Heyder, Ludwig Theuvsen and Thorsten Hollmann – Hespos has done a survey on 234 food manufacturers in Germany and come to a conclusion that enormous external pressure in the consumer market is the dominant factor that drives enterprises to accelerate the construction of traceability system^[13].

Above all, the current situation of traceability system application by domestic food manufacturers allows of no optimism. The existing market environment cannot help the manufacturers applying traceability system to gain more profit. Furthermore, it is lacking in negative incentives to force food manufacturers to apply the traceability system. In this way, rational food manufacturers lack motivation to apply the food traceability system, which slows down the overall progress of traceability system application in China. For overseas food manufacturers, the application of traceability system is guaranteed by mandatory requirements of legal aspects and tangible benefits brought by the traceability system. In this way, traceability system has been promoted very smoothly. There-

fore, the weak willingness of domestic food manufacturers to cognize and apply traceability system is one of the key reasons that restrict the application process of food traceability system in China.

4 Technical means of food traceability system

The traceability of information on food quality and safety is a mode of information transfer on the basis of technology. However, how can we know that whether the technologies used for food traceability system are mature enough now? Aiming at this problem, the author has summarized the research achievements of technical experts for food traceability system and found that the technical difficulties of food traceability system have been overcome.

Xie Juhua, Luchanghua and Li Baoming have been dedicated to the research on the design of pork traceability system on the basis of .NET framework. In view of the links including breeding, slaughter and sale *etc.*, two-dimensional bar code technology, radio frequency identification (RFID) and component technology have been applied to provide individual identifiers for the pork. By means of Internet server, this system helps to ensure the traceability of pork information in the entire supply chain^[14]. In the research of Zhao Yingwen and Li Xiao, they make live pigs wear RFID electronic ear tags and record all information on breeding, slaughter, transportation and sale timely. Consumers can search the files of pork products through the internet, self-service inquiry terminals or phone & texts^[15]. Li Lishan, Tian Yumin and Su Yuhong have also researched on the design of pig traceability system on the basis of RFID tag technology. This system consists of data collection, data authentication, data storage, data use and other relevant links. Breeding data is processed in the way of multipoint input and unified authentication, and the animal health supervision authority is responsible for verifying data authenticity^[16]. Hu Dong and Xie Jufang have proposed a pork traceability system that enables remote monitoring and terminal information inquiry on the use of drugs and feeding stuff and the breeding environment in the process of pig breeding through text messages by means of public wireless network^[17]. Applying database technologies of Visual Basic6.0 and SQL Server 2000, Zeng Xing, Yang Zhongping and Pan Jiarong have established a Web-based pork traceability system targeting at the safety information about the links including pig breeding, slaughter and sale^[18]. Xiong Benhai, Fu Runting and Lin Zhaohui *et al.* have designed to provide individual identification for live pigs applying 2D ear tags and body labels. Specific information in the breeding process of live pigs is scanned and collected with smart handheld PDA and GPRS net, and then uploaded to the server of pork traceability system^[19]. Domestic and foreign experts of pork traceability system have applied different methods to identify individual pigs with modern techniques. And through this identification, relevant data is copied and transmitted in each intermediate link so as to form an information flow for pork products. Consumers can trace pork information by means of Internet or mobile terminals through the labels on the pork purchased.

From the above, technical obstacles in establishing food

traceability system have been broken through, and a series of advanced technologies have been integrated into the construction of food traceability system. Existing technologies are sufficient for establishing a food traceability system targeting at improving food safety and safety and strengthening risk management over food safety and safety. However, the willingness of food manufacturers to apply the traceability system is relatively weak, which is not because of the high development costs in traceability technologies, but the cost rising after the application of this system. Driven by the price factor, whether consumers are willing to buy the food with traceable function will have a direct impact on the interests of food manufacturers. Therefore, consumer behavior will affect the decision of food manufacturers on applying the traceability system.

5 Cognizing and purchasing intention of consumers regarding food traceability system

The consumers' intention of cognizing and purchasing the food with traceable function has a direction impact on the decision of food manufacturers as for whether to apply the traceability system. Relevant scholars have done a lot of research on the intention of domestic consumers to cognize and buy the food with traceable function.

Through the analysis on the purchasing behavior of 444 consumers in Shanghai with regard to the traceable beef, Zhou Yingheng, Wang Xiaoqing and Geng Xianhui have found that 51.8% of them have a poor understanding of the beef with traceable label, and only 50.73% of the respondents express their willingness to buy traceable beef^[20]. Wang Feng, Zhang Xiaoshuan and Mu Weisong *et al.* have conducted a survey on 182 consumers in Beijing, Shandong Province and Zhejiang Province *etc.*, and the result indicates that 84.1% of the consumers have a poor understanding of the traceable food, 79.6% of them are willing to buy traceable agricultural products at a premium of lower than 15%, and only 30.1% of them are willing to pay a price of higher than 10%^[21]. The survey conducted by Zhao Rong, Qiao Juan and Chen Yusheng on the willingness of consumers in Beijing to buy traceable food indicates that only 1.9% of the respondents are very familiar with traceable food. In the matter of purchasing intention, up to 86.4% of the respondents have expressed their willingness to buy. But after considering the price premium, only 46.6% of them are still willing to buy, and the other 52.4% are only willing to pay an extra 10% or 20%^[22]. Through the investigation on consumers in Jiangsu Province, Wu Linhai and Xu Lingling have found that 38% of the consumers are not willing to pay a premium price on traceable food. And among the consumers with a willingness to pay, 95.8% of them do not want to pay a premium of higher than 30%. The above authors have also conducted a survey on the willingness of 1 757 consumers in 13 cities of Jiangsu Province to buy traceable food, and the result turns out that 37% of the respondents are familiar with the food traceability system, and 33.3% of them have expressed their willingness to buy traceable food^[23,24]. Qi Shengmei, Du Lei and Jiang Naihua *et al.* have

investigated the cognitive and purchasing behaviors of the consumers in Yangzhou City with regard to traceable pork. It turns out that 88.2% of the consumers show little understanding of traceable food, 47.3% of them are willing to pay a price premium of less than 10%, and 44.6% of them are willing to pay a premium of 10%–20%^[25]. Through the research on the understanding of traceable food among 321 consumers in Harbin, Shang Xudong, Qiao Juan and Li Binglong find that 63.91% of the consumers have never heard of traceable food. Although 71.33% of the consumers have expressed their willingness to buy traceable food, 30.84% of them do not want to pay a premium for this. The above authors have also investigated the purchasing intention of 730 consumers in Guangzhou and Harbin towards traceable food. Among these consumers, 63.70% of them have never heard of traceable food, and 239 respondents do not want to pay extra price for the traceable food^[26,27]. Through the investigation on the paying intention of 823 consumers in Shanghai towards traceable fresh fruit, Hou Xige finds that 86.4% of the consumers are willing to buy traceable fresh fruit without considering the price. Once the price increase is taken into consideration, only 46.17% of them are still willing to buy traceable products^[28]. Chen Yusheng, Yang Xiancui and Zhou Hailing have investigated the purchasing behaviors of 520 consumers in Qingdao, Beijing and Guangzhou with regard to traceable aquatic products. 58% of the consumers think that the price of traceable aquatic products is on the high side. As a result, 45.6% of them have expressed their unwillingness to buy^[29]. The investigation conducted by Yang Beibei and Wu Xiumin on the purchasing intention of 341 consumers in Chengdu towards traceable agricultural products indicates that 65.98% of the consumers have heard of the traceable agricultural products. 53% of the respondents have expressed their willingness to buy traceable agricultural products, and 45.05% of them are willing to pay a premium of 10%. Few consumers are willing to pay a premium of higher than 30%^[30]. Han Yang and Qiao Juan have analyzed the purchasing intention of 566 consumers in Beijing towards traceable food as well as the influencing factors. The results show that the consumers do not have a strong intention to buy traceable food^[31].

Foreign scholars have also carried out related studies on the cognitive and purchasing behaviors of consumers with regard to traceable food. Gracia and Zeballos *et al.* have investigated and analyzed the attitude of Spanish consumers and retailers towards the enforcement of traceable identification system for beef supply chain. It turns out that the consumers and retailers think highly of the beef traceability system^[32]. Taking pork and beef for example, David has researched the paying intention of American and Canadian consumers towards the traceability system. The results show that American consumers are willing to pay a premium of \$0.21 (7% higher than the base price), and Canadian consumers are willing to pay a premium of \$0.54 (18% higher than the base price)^[33]. The research conducted by Hobbs, Dickson and Bailey *et al.* indicates that consumers with a strong sense of food safety

have expressed a stronger paying intention towards the origin identification and traceable food. And through the investigation on Canadian consumers, it is found that 52% of them accept and are willing to pay for the food with traceability information. The above authors have also investigated the willingness of American consumers to pay a premium on the meat traceability system, and the results show that American consumers are willing to pay price premiums of \$0.23 and \$0.5 for beef and pork respectively^[34]. Through the analysis on the awareness of 278 beef consumption households in Belgium with regard to the traceability, quality mark and original mark of beef and its products, Verbeke and Ward have found that the consumers prefer to choose the food with striking quality certification mark, original mark and traceability identification^[35]. Cicia and Colantuoni have summarized the studies conducted by foreign scholars on the willingness of consumers to pay for traceable meat products. They have found that consumers abroad show stronger willingness to pay for the food with traceable function and are willing to pay a price premium of 7%–16% of the base price^[36]. Rijswijk and Frewer have conducted a research on the attitude of 357 consumers in different regions of the European Union towards the safety information of food traceability system, which indicates that the consumers attach great importance to all kind of effective information in the food production processes. And they believe that strict and accountable traceability system is conducive to real and effective information transmission of food safety information^[37]. Loureiro & Umberger and Pouliot & Sumner have conducted empirical researches respectively on the paying intention of consumers in different countries and different environments towards the traceability by using the methods including selection experiments and discrete choice model. The results show that the consumers are willing to pay a high price for the food traceability system^[38,5].

Related literature home and abroad has elaborated the cognition level and purchasing intention of consumers with regard to traceable food, and has proved that individual behaviors of consumers have a major impact on the food manufacturers' application of traceability system. By comparing the researches of domestic scholars with that of foreign scholars, the author finds that the consumers in China have a low cognitive level on food traceability system. Although consumers have a strong intention to buy traceable food, they do not want to pay a high premium. By contrast, overseas consumers have a higher cognition level and stronger pay intention on traceable food. Besides, they are willing to pay a higher price premium. To some extent, the foreign market has fostered food manufacturers who apply the traceability system voluntarily. In contrast, although domestic manufacturers apply the traceability system, the consumers do not want to pay a price premium for it. This goes against the objective of food manufacturers to maximize self-interests. With insufficient positive incentives in the market, the intention of food manufacturers, as rational-economic men, to apply traceability system has been weakened. This has resulted in a low application rate of food traceability sys-

tem among manufacturers in China. Therefore, consumer behavior is also one of the significant causes that lead to a slow application process of food traceability system in China.

6 Legal environment of food traceability system

Mandatory and restrictive legal system provides security for system implementation. The promotion and popularization of food traceability system and the motivation for food manufacturers to apply traceability system in any country can not happen without the strong support of legal system. A sound system of laws and regulations will also play a role in enforcement and supervision while encouraging food manufacturers to apply traceability system. In this way, bidirectional regulation will be provided for food manufacturers from both positive and negative aspects. Therefore, the formulation of laws regarding food traceability system in a country (re-

gion) will have a direct impact on the implementation, promotion and popularization of the food traceability system.

In the countries or regions like the European Union, America and Japan, the foundation for the establishment of food traceability system is a set of legal system suitable for this system. On the basis of a sound legal system, the government will be able to promote and popularize the food traceability system according to certain rules. With the mandatory constraints of laws and regulations, food traceability system will become a market access system, which means that only traceable food is allowed to enter the market. That is to say, the cost of establishing food traceability system has been internalized into the constant cost of food manufacturers to obtain market access. Under the influence of a sound legal environment, it has become the inherent and natural choice of food manufacturers to apply the traceability system.

Table 1 Overview of legal environment for food traceability system in developed countries (regions)

Country (Region)	Form	Legal basis	Features
European Union	Official monitoring	<i>White Paper On Food Safety Regulation No. 178/2002</i>	The concept of whole process supervision "From the Field to Table" has been proposed for the first time. All the food products to be sold in the whole region of European Union are required to be trackable and traceable. Otherwise, they are not allowed to go on sale.
America	Government enforcement & enterprise voluntariness	<i>Food Safety Tracking Regulations</i>	All enterprises involved in food transport, distribution and import are required to keep a whole process record on related food circulation.
Japan	Official promotion	<i>Guide for Food Traceability System Food Safety Basic Law</i>	- - -

* Date source; References

But in China, the government hasn't formulated any legal provisions specialized in food traceability system. Even in the latest revision of Food Safety Law, there is still a lack of provisions related to food traceability system. The government has only introduced related regulations, standards and patterns, but neglected the necessity of laws in the promotion of food traceability system. The lack of legal restriction and supervision has led to the situation that both traceable and non-traceable food products are allowed to enter the marked, which means that the feature of food traceability system as a market-entry barrier has been disabled. In the case of insufficient positive incentives in consumer market and a lack of legal restriction and supervision over food manufacturers, the application of food traceability system among food manufacturers remains difficult.

Thus it can be seen that a complete legal system plays a crucial role in promoting the application of food traceability system. Legal restriction and supervision are essential conditions for food manufacturers to apply the traceability system. With a complete legal system established and a sound legal environment created, food manufacturers will take the initiative to apply traceability system when they are aware of the losses causing by refusing to apply this system.

7 Conclusions and suggestions

7.1 Relevant conclusions This paper has discussed whether manufacturer application, technical means, cognizing & purchasing intentions of consumers and legal environment are significant causes for the slow application process of food traceability system in China. Research results show that technical means is no longer a bottleneck that hinders the promotion and popularization of food traceability system in China. In fact, poor awareness of food traceability system and weak purchasing intention of consumers, legal deficiency and the manufacturers' weak intention in applying the system are the key factors that lead to a slow application process of food traceability system in China. Because of the above factors, food traceability system has been perceived to have a relatively weak impact in maximizing the interests of food manufacturers. There is a lack of internal motivation and external enforceability for manufactures to apply the traceability system. That is why the application of food traceability system in China has been in such a slow progress.

7.2 Policy suggestions First is perfecting relevant laws and regulations to create a sound legal environment. A sound and complete legal system plays a foundational role in the promotion of food traceability system. To some extent, mandatory constraint of

relevant laws and severe punishment imposed on law breakers will prompt the food manufacturers to apply the traceability system so as to improve their risk management level while securing food quality and safety.

Second is strengthening the construction of publicity system to improve the cognitive level of consumers. It is difficult to achieve a substantial growth in the income level of consumers within a short span of time. In this case, the paying intention of consumers towards traceable food can only be enhanced through improving their cognitive level on food safety and the traceability system. Strengthen the construction of publicity system for food traceability system and improve consumer awareness of the traceability system so as to improve the willingness of consumers to buy traceable food.

Third is improving the cognitive level of enterprises to secure food quality and safety. Under the combined action of legal restriction and market incentives, improve the cognitive level of enterprises on traceability system and make them aware of the long-term benefits brought by the application of traceability system.

7.3 Research prospects From the point of economics, the safety investment level of food enterprises depends on the practical comparison of the expected premium revenue from safety investment to the expected risk losses. Both the high premium revenue obtained from improving the safety level of products and the high risk costs caused by the production of unsafe products can motivate food enterprises to increase safety investment. The difference is that the former is a negative incentive and the later is a negative incentive.

In the current market environment of China, the effect of positive incentives can hardly motivate food enterprises to increase safety investment. Therefore, the author plans to introduce negative incentive into the research on the application of traceability system by food enterprises. Negative incentive means to increase the risk costs of food enterprises on account of a neglect of product safety. According to their respective risk capabilities, food enterprise may choose to exit or take preventive measures so as to strengthen quality control and avoid safety risks.

In the research of the next stage, the author wishes to build a principal-agent model and deduce the participation constraints and incentive compatible constraints for food enterprises to apply the traceability system from the perspective of negative incentive-risk costs. And on the basis of this theoretical model, the author will conduct empirical analysis and calculate the probability premium and punishment intensity for food enterprises with respect to the application of traceability system, and then come to the main conclusions of the study by comparing the critical values of risk costs among companies of varying sizes and different safety problems.

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Therefore, the trademark registration and publicity of national geographic indications for "Hefeng Green Tea" and "Hefeng Yihong Black Tea" should be promoted so as to build them as the regional public brands of agricultural products in China and recognize them as "China Famous Trademark".

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