

## Research Article

### A Seamless Food Safety Supervision System of Edible Agricultural Products

Kefei Liu

School of Economics and Trade, Henan University of Technology, Zhengzhou 45001, China

**Abstract:** Food safety relates to people's health, society's stability and national economy's development. However, the current security situation of edible agricultural product is a concern and it is urgent to solve this problem. This study analyzes the current food safety situation and existing problems of edible agricultural products, theoretically discusses externalities and asymmetric information of edible agricultural products safety and proposes the conception of constructing safety supervision system of edible agricultural product through learning from the advanced experience of food safety management and based on seamless organization theory.

**Keywords:** Asymmetric information, externality, food safety, seamless organization, supervision system

#### INTRODUCTION

Constructing the basic theory of the safety supervision system of edible agricultural products can apply the seamless organization theory emerging in recent years in Western countries. Since 1990s, aiming at the great changes occurring in various fields like technology, politics, global economy and needs and preferences of citizens on a global scale, the government of Western developed countries launched a quiet revolution in public administration. Linden created the concept of "seamless organization" in 1990, which means the words of mobile, flexible, elastic, complete, transparent, coherent and so on can be used to describe organizational form; it is an organizational change to meet customers' seamless requirements (Herra and Martinez, 2001).

Seamless organization theory provides a much-needed theoretical guidance for the reconstruction of government and other public sectors, which is a self-reforming mode of future-oriented public institutions. Seamless organization theory is widely used in the reconstruction of public sectors in developed countries, but China's research on the theory is little. In 2001, Lin Dahai introduced seamless organization theory into China through translating Linden's writings. Li Weining and Lan Changgao, Wang Qiyang, Long Zhaohui discussed the application of seamless organization theory in China's tax collection successively. In 2007, Zhao Laijun discussed the specific application of seamless organization theory in the safety supervision of dangerous chemicals and fire in China. The core concept of "global", "whole", "integrated" and "seamless service" and the basic principle of result-oriented and process-oriented of

seamless organization theory are very suitable for China's safety supervision system construction of edible agricultural products.

According to information released by the World Health Organization, every year the incidents of over 100 people's food poisoning caused by foodborne pathogens are as many as 100,000. Given the importance of food safety issues, developed countries have established strict food safety regulatory system to ensure people's food security and health (Sobh *et al.*, 2014). However, in recent years, the food safety incidents occurring frequently around the world, such as BSE, foot and mouth disease in Britain, dioxin in Belgium, bird flu in Asian, forces various countries to take all measures to supplement and improve the system (Linden, 1994). Among these developed countries, the measures of the United States, European Union and Japan are especially effective and their food safety regulatory systems are also the most representative. Objective of the study is to establish the overall goal of seamless safety supervision system of edible agricultural products. Following safety supervision system law of edible agricultural products, strengthening the building of legislative, judicial and law enforcement capacity, strengthening production and circulation process monitoring of edible agricultural products, enhancing safety management capacity and level of edible agricultural products, ensuring safe production and consumption of edible agricultural products and increasing international competition force of edible agricultural products are the overall goal of seamless organization reconstruction conducted by safety supervision system of edible agricultural products. According to the overall objective, seamless safety supervision system of edible agricultural products is constructed.

## **MATERIALS**

Theoretical and practical experience has proved that the safety supervision of food cannot rely on market regulation alone, the government must play a leading role in this and special attention should be attached to the supervisory role of a third party, which is determined by food safety's characteristics of externalities, information asymmetry and so on.

**Analysis on the externality of edible agricultural products:** Externality refers to the production or consumption causes forced cost of other groups or gives profits without compensation (Lee and O'Mahony, 2005). The externalities related to edible agricultural products safety include the following situations.

**Externality generated by modern industrial production:** Modern industry provides the necessary means of production for agriculture production and increases productivity, but modern industrial production releases "three wastes" into the nature and the resulting acid rain causes a serious threat and destruction to natural and ecological environment. While agriculture production has a strong dependence on natural resources and ecological environment, harsh natural and ecological environment seriously affects the quality and safety of agricultural products and modern industry has a serious negative externality to agricultural production.

**Externality generated by modern agriculture, animal husbandry and fishery production:** Although the application of modern agricultural production like fertilizers, pesticides, plastic and its like can improve product yield, the blind abuse will inevitably affect the environment and agricultural product itself. The abuse of animal feed and additives not only decreases the quality of livestock and fishery products, but also poses a major threat to the health of consumers through bioaccumulation.

**Externality generated by scientific and technological progress:** Scientific and technological progress makes some previously unrecognized product safety hazards continue to be found, which brings positive impact on food safety. But science and technology is a double-edged sword and also has its downside for food safety. Once the side effects of scientific and technological achievements break out, huge external negative effects may arise, including serious damage to the environment and serious threat to human health.

**Externality generated by asymmetric information:** Because there is a serious problem of asymmetric information in product market, the safe products sold by the producer of high-quality edible agricultural

products enable the seller of fake products to receive additional income; on the other hand, the fake agricultural products sold by the producer of inferior edible agricultural products not only impact consumers' health, but also make the consumers have a negative impression of the product, which damages the selling of high-quality safe edible agricultural products.

Externality is within the scope of market failure and the price mechanism can not play its role of economic efficiency. Therefore, the solution of the externalities in safety of edible agricultural products can not only rely on market forces and the government should take direct or indirect measures to regulate, such as tax (or subsidy) or government regulation, so that external costs generated by producers or consumers enter into their production or consumption decisions, borne by themselves, which makes up the difference between the external costs and social costs.

**Analysis on the information asymmetry of edible agricultural products:** The problem of asymmetric information always exists in the production and circulation process of edible agricultural products. Asymmetric information and the lack of effective supervision and management mechanism of agricultural products in the market are the major reasons for the emergence of agricultural security issues (Allison and Work, 2004). Edible agricultural products are "experienced products" or even "posterior products", that is, the safety issues of edible agricultural products can only be experienced and understood after being consumed by the consumer and pesticide residues and other issues to a certain extent can hardly be found even by testing. Some of the potential hazards may exist for a long time and won't show itself in the short term, but it will emerge once accumulating to a certain extent. Meanwhile, the production and circulation chain of edible agricultural products prolongs, the parts increases, each process lacks of traceability and the nosogenesis of consumers is so complicated that it is difficult to distinguish the real reason, leading to the growth of a number of producers and traders who deliberately conceal information and deceive consumers. Figure 1 shows the general production and circulation chain of edible agricultural products and there is a serious problem of information asymmetry in the process from the initial agricultural inputs of dealers to the consumption by consumers.

**Asymmetric information between farmers and agricultural means of production provider:** Currently agricultural means of production is mainly sold by agricultural materials companies. Agricultural materials companies have managed agricultural commodities for a long term, have a sound marketing network and can easily collect information. Therefore, their market information is much richer than the

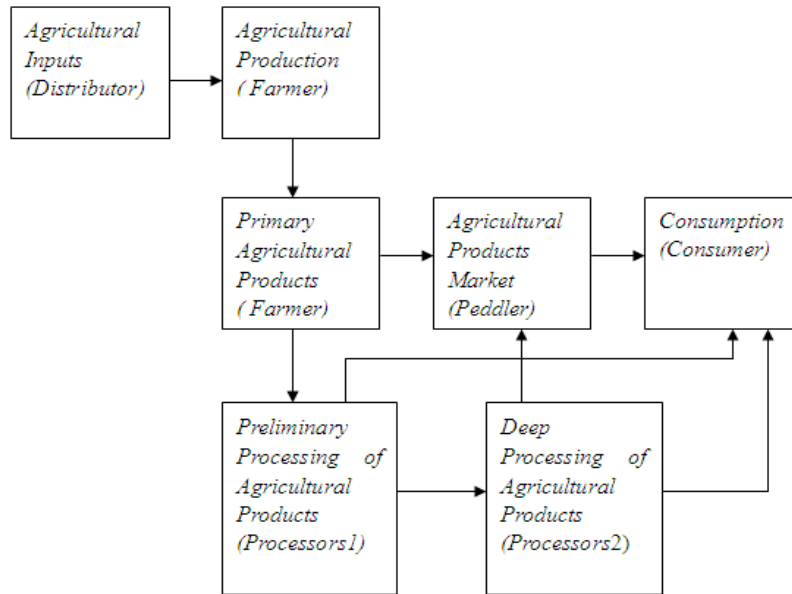


Fig. 1: Production and circulation chain of edible agricultural products

farmers and for their own interests, they often transmit false information to the farmers by misleading, concealment, fraud and other means. In the agricultural market, farmers cannot have enough information, if farmers can not discern genuine and fake goods, excellent and defective products, there would be the phenomenon of "sub-standard goods drive out good goods".

**Asymmetric information caused by agricultural production features:** For the initial investment of agricultural production in the production of animal and plant products, it would take some time to know the true extent of the investment products, for example, the quality of seeds can only be found out after the harvest and the quality of fertilizer can only be determined after being applied for some time. Moreover, there are lots of factors that would affect the final quality of agricultural products, such as complex natural conditions and production processes. It is often difficult for farmers to distinguish the real cause of agricultural products' quality and safety issues.

**Asymmetric information between farmers and buyers or peddlers:** From the perspective of the buyers, buyers are often unable to keep abreast of the farmer's production levels and personal credibility because of information search costs. Farmers often hide the real information of products in order to pursue personal interests. However, farmers also face the problem of asymmetric information, mainly the incomprehension of market supply and demand information, while the agricultural products processing enterprises have a wealth of market information. In

order to obtain higher profits, the phenomenon of misinformation and false information transfer often occurs.

**Asymmetric information between processing enterprises and all levels of peddlers:** As the processing enterprises of edible agricultural products have a low requirement on capital and technology, the barrier to enter industry is low and there are many food processing enterprises, especially middle and small-sized enterprises, which account for the vast majority. These middle and small-sized enterprises have many food safety problems, such as poor equipment, backward technology, poor production environment, shoddy products and so on. In pursuit of the lowest cost, peddlers at all levels can not timely understand the product quality of processing enterprises or simply are unwilling to spend a greater cost to understand.

**Information asymmetry between processing enterprises:** In order to increase the added value of products, primary agricultural products generally go through preliminary processing and deep processing sectors. Primary processing enterprises, as a supplier, have a clear understanding of their own product quality, while deep processing enterprises do not have the information superiority over primary products and the same condition also exists among various levels of processing enterprises.

**Information asymmetry between final consumers and peddlers or processing enterprises:** Peddlers and processing enterprises usually have the information superiority of product quality while the majority of

consumers are obviously at an information disadvantage. In the case of inadequate market regulation, consumers are always the victims. The more sectors that the products go through are, the severe of information asymmetry from the source to the final consumer is. Assuming real rate of the information for each link is  $K$ , the real rate of information is  $K^n$  after  $n$  links. Taking the production and circulation chain of edible agricultural products as an example, if the real rate of information of various links from agricultural products input to the final consumer is 0.95, then after  $n$  links, the real rate of information is  $0.95^n$ . Taking the shortest production and circulation path A-B-D-J as an example, the real rate of information obtained by the final consumer is only  $0.95^4 = 0.8145$ . The longer the production and circulation chain of edible agricultural products is, the lower the real rate of product information of final consumer is. Therefore, reducing products production and circulation parts to reduce information asymmetry is an effective way to improve food safety.

**METHODS**

**Ordered discrete selection model and estimation:** In the practice of security risk assessment of agricultural products, figures are used to represent the corresponding assessment results, the numeral value reflects the risk level and assessment model corresponding to such problems can apply ordered discrete selection model. Assuming  $y$  represents the response variable of sequence class number  $k+1$ , that is the ordered categorical response variable that selects a value in  $\{0,1,\dots,k\}$ , the explanatory variables are  $x_1, x_2, \dots, x_m$  and the corresponding ordered discrete selection model is (Elortondo *et al.*, 2007):

$$y^* = \beta^T x + \varepsilon \tag{1}$$

where in  $x = (x_1, x_2, \dots, x_m)^T$  is a vector composed of the explanatory variables,  $\beta$  is the parameter vector,  $y^*$  represents effectiveness evaluation value, which is an unobservable continuous variable and the things can be only observed are:

$$\begin{aligned} y &= 0(y^* \leq \alpha_1) \\ y &= 1(\alpha_1 < y^* \leq \alpha_2) \\ &\vdots \\ y &= k(y^* > \alpha_k) \end{aligned} \tag{2}$$

where in  $\alpha_1 < \alpha_2 < \dots < \alpha_k$  represents an unknown threshold parameter (Cut Point).

In this study, the assumption of  $\varepsilon$ -Logistic distribution can be applied and the following  $\varepsilon$ -Logistic model can be obtained:

$$\begin{aligned} P(y=0) &= P(y^* \leq \alpha_1) = P(\beta^T x + \varepsilon \leq \alpha_1) = \Lambda(\alpha_1 - \beta^T x) \\ P(y=1) &= P(\alpha_1 < y^* \leq \alpha_2) = \Lambda(\alpha_2 - \beta^T x) - \Lambda(\alpha_1 - \beta^T x) \\ &\vdots \\ P(y=k-1) &= P(\alpha_{k-1} < y^* \leq \alpha_k) = \Lambda(\alpha_k - \beta^T x) - \Lambda(\alpha_{k-1} - \beta^T x) \\ P(y=k) &= P(y^* > \alpha_k) = 1 - \Lambda(\alpha_k - \beta^T x) \end{aligned} \tag{3}$$

Through derivation:

$$P(y=0) + P(y=1) + \dots + P(y=k) = 1 \tag{4}$$

The unknown parameters of Eq. (3) include threshold  $\alpha = (\alpha_1, \alpha_2, \dots, \alpha_k)^T$  and parameter vector  $\beta$  which can be acquired by MLE (maximum likelihood estimation). Construct the log-likelihood function, shown as follows:

$$\begin{aligned} \ln L(\alpha, \beta) &= [y=0] \ln[\Lambda(\alpha_1, \beta^T x)] + 1 \\ &[y=1] \ln[\Lambda(\alpha_2, \beta^T x) - \Lambda(\alpha_1, \beta^T x)] + \dots + \\ &1[y=k] \ln[1 - \Lambda(\alpha_k, \beta^T x)] \end{aligned} \tag{5}$$

Maximize the above function to get the MLE value  $\hat{\alpha}$  and  $\hat{\beta}$  of  $\alpha$  and  $\beta$ .

**Discriminant analysis based on the ordered Logistic regression model:** When the ordered LOG model is used in security risk assessment of agricultural products, the “sequence class number -1” regression equations are often adopted to describe the relationship between the independent variable (forecast variable) and the response variable. Therefore, it is possible to utilize the following  $k$  simultaneous regression equations:

$$\begin{aligned} \ln \frac{q_0}{1-q_0} &= \alpha_1 + \beta_1 x_1 + \dots + \beta_m x_m + \varepsilon_1 \\ \ln \frac{q_1}{1-q_1} &= \alpha_2 + \beta_1 x_1 + \dots + \beta_m x_m + \varepsilon_2 \\ &\vdots \\ \ln \frac{q_{k-1}}{1-q_{k-1}} &= \alpha_k + \beta_1 x_1 + \dots + \beta_m x_m + \varepsilon_k \end{aligned} \tag{6}$$

where in  $q_j = \sum_{i=0}^j P(y=i), j=0,1,\dots,k-1$ .

Combine with Eq. (4) to acquire  $q_k = 1$  and the discriminant rate of  $\frac{q_j}{1-q_j}$ , that is, the occurrence rate

of a certain class.  $\alpha_1, \alpha_2, \dots, \alpha_k; \beta_1, \beta_2, \dots, \beta_m$  can be obtained by MLE.

Establish the simultaneous equations as shown in (6) and then conduct risk assessment for the new sampled agricultural base by the appropriate statistical tests. For a set of explanatory variables  $x_1^*, x_2^*, \dots, x_m^*$ , put it into Eq. (6) to solve  $q_{k-1}, \dots, q_1, q_0$ , thereby

obtaining the probability  $p_1, p_2, \dots, p_k$  of sequence class  $0, 1, 2, \dots, k$ :

$$\begin{aligned} p_0 &= q_0 \\ p_1 &= q_1 - q_0 \\ &\vdots \\ p_{k-1} &= q_{k-1} - q_{k-2} \\ p_k &= 1 - q_{k-1} \end{aligned} \quad (7)$$

where in  $p_j = P(y = j), j = 0, 1, \dots, k$ . If  $p_j = \max_{0 \leq j \leq k} P_j$ , the security risk level of agricultural products from this base are assessed as  $i$ .

## RESULTS AND DISCUSSION

### Establishing the overall goal of seamless safety supervision system of edible agricultural products:

Following safety supervision system law of edible agricultural products, strengthening the building of legislative, judicial and law enforcement capacity, strengthening production and circulation process monitoring of edible agricultural products, enhancing safety management capacity and level of edible agricultural products, ensuring safe production and consumption of edible agricultural products and increasing international competition force of edible agricultural products are the overall goal of seamless organization reconstruction conducted by safety supervision system of edible agricultural products. According to the overall objective, seamless safety supervision system of edible agricultural products is constructed:

- In term of legal regulations and standards, preventing food contamination and protecting consumers' "right to health" through legislation have become a major feature of the developed countries' food safety regulation. Laws and regulations system of edible agricultural products safety is a network structure that covers all aspects associated with the safety of edible agricultural products and there is no "dead angle". In the United States, there are comprehensive laws like "Food Quality Protection Act," "Public Health Service Act" and its like and specific law like "Inspection Act of Egg Products". Quality standard of edible agricultural products has wide coverage and large quantities (Herrra and Martinez, 2000). Safety laws, regulations and quality standards for edible agricultural products in various countries are in constant revision and perfection.
- In developed countries, safety management agency of edible agricultural products is relatively sound, the operation is standardized and consumers' right to know can be ensured through the

implementation of HACCP and food traceability system (Prasanna and Raghunathan, 2014). Implementation of product identification and authentication system can make consumers understand the overall information of the quality of edible agricultural products and meanwhile can put pressure on the producers. Based on risk analysis, implementing HACCP system, strengthening GAP and GMP management and strengthening the whole monitoring process of edible agricultural products. Implementing food recall system. Promoting food traceability system. By traceability system, a variety of quality recording of the production process can be traced, to understand the conditions and operation personnel in the working process. Once the problem is found, the cause be quickly identified and then measures can be taken.

- Support system is an important part and basic guarantee of the food safety regulatory system in developed countries, including providing funding, supporting scientific research, strengthening advocacy and encouraging public participation.
- Through legislation, law enforcement and judicial division, to guarantee fairness, impartiality and open of institution; through sound local laws and regulations, to specify the responsibilities and rights of various aspects of production, supply and sale; through joint supervision and management of various departments, to control all aspects of edible agricultural products safety (Jing *et al.*, 2015); through joint participation and cooperation of producers, consumers and government and execution and mutual supervision of legislative, judicial and law enforcement authorities, to ensure the transparent, stable, efficient and seamless operation of entire safety regulatory system of edible agricultural products.
- Legislative sector constrains the behavior of each subjects through formulating national laws and regulations to identify the right and safety responsibility of each subject and government in the edible agricultural product chain. Laws, regulations and standards of food safety is the cornerstone of the entire management system and the basis of regulating disputes by law enforcement agencies and judicial agencies (Xia and Song, 2001). Safety management of edible agricultural products involves the areas of production, supply and selling and it requires to mobilize the power of the relevant law enforcement agencies, such as agriculture, commerce, environmental protection, quality control, industrial and commercial sectors, so as to make concerted efforts to create synergy. Therefore, it is necessary to set up a joint law enforcement agencies, so as to organize, lead and coordinate the work of each law enforcement agency, to change the phenomenon of scattered and

fragmented rights in various departments, to block regulatory loopholes, to establish food safety regulatory responsibility and accountability system according to the principles of consistent responsibility and authority and improve the efforts and efficiency of safety management of edible agricultural products.

- Conducting seamless monitoring for the entire chain of edible agricultural products and strengthening the management on the links of environment of producing edible agricultural products, agricultural inputs, production process, circulation process, market environment and so on. Each link should have clear standards and regulations, supervision and law enforcement from corresponding law enforcement departments should be enforced between links, to ensure each production and circulation subject in the chain of edible agricultural products is under close supervision and also ensure the production and circulation subject has standardized operation and laws to go by. It mainly includes strengthening environmental management of producing agricultural products, strengthening market supervision and management of inputs and vigorously promoting standardized agricultural work and HACCP management and strengthening the edible agricultural products circulation and market environment construction.
- Strengthening the construction of support system and establishing agricultural products' quality safety management structure of government domination, industry collaboration and public participation. It includes financial security, construction of social intermediary organization and public education.

### CONCLUSION

To ensure food safety, the full control from farm to table requires the cooperation of various parties and governments, businesses and consumers all have responsibilities, to build seamless regulatory networks based on seamless organization theory. All levels of government are mainly to conduct scientific research, develop laws, regulations and standards and then to implement; enterprises are mainly to form good practices and establish quality control and assurance system in accordance with the standard. And consumers should continue to enhance food safety awareness, monitor and give feedback the problems occurring in various aspects of food safety. Safety regulatory system of edible agricultural products is a constantly changing

dynamic system, requires timely revision and improvement. Only through "advancing with the times" would the system hold up the protective umbrella for the safety of China's edible agricultural products.

### ACKNOWLEDGMENT

This study is supported by the National Natural Science Foundation of China (Grant No.U1304706) and the Henan University Science and Technology Innovation Talents Support Program (Grant No.CXRC201410).

### REFERENCES

- Allison, A.M. and T. Work, 2004. Fiery and frosty foods pose challenges in sensory evaluation. *Food Technol.*, 58: 108-119.
- Elortondo, F.J.P., M. Ojeda, M. Albisu, J. Salmeron, I. Etayo and M. Molina, 2007. Food quality certification: An approach for the development of accredited sensory evaluation methods. *Food Qual. Prefer.*, 18(2): 425-439.
- Herrra, F. and L. Martinez, 2000. A 2-tuple fuzzy linguistic representation model for computing with words. *IEEE T. Fuzzy Syst.*, 8: 746-752.
- Herrra, F. and L. Martinez, 2001. A model based on linguistic 2-tuples for dealing with multi-granular hierarchical linguistic contexts in multi-expert decision-making. *IEEE T. Syst. Man Cy. B*, 31: 227-234.
- Jing, X., J. Zhang and Y. Zhao, 2015. An efficient complex event processing system having the ability of parallel processing and multi event pattern sharing. *J. Intell. Fuzzy Syst.*, 28: 885-896.
- Lee, H.S. and M. O'Mahony, 2005. Sensory evaluation and marketing: Measurement of a consumer concept. *Food Qual. Prefer.*, 16: 227-235.
- Linden, R.M., 1994. Study on food safety issues. *Food Technol.*, 6: 78-89.
- Prasanna, K. and D. Raghunathan, 2014. Effect of bael bark extracts against *Escherichia coli*-a food borne pathogen. *Biotechnol. Indian J.*, 9: 138-142.
- Sobh, M., N. Chaouche, A. Fadli and M. Ouhssine, 2014. Application of a system of quality control to improve the conservation of the artichoke in an industrial unit in Morocco. *Biotechnol. Indian J.*, 9: 225-241.
- Xia, Y. and B. Song, 2001. Food security: From the quality standard system to supply chain management. *Issues Agric. Econ.*, 11: 59-62.