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## The industry chain-based food quality and safety management system construction

Liu Ke-Fei

School of Economics and Trade, Henan University of Technology, Zhengzhou, 45001, (CHINA)

### ABSTRACT

Food quality and safety has attracted much attention in recent years. In this paper, the food industry chain is studied, and based on which a system aiming at food quality and safety management is built to improve the level of food quality and safety. Considering the different development stages of the food industry chain, we construct two food quality and safety management systems, e.g. system-1 and system-2, which are then compared to show their differences and connections. It is concluded that food quality and safety management needs the cooperation between the executive branches of the government and all the food industry chain nodes.

### KEYWORDS

Industry chain; Food quality and safety; Management system.



## INTRODUCTION

Food quality and safety accidents occur frequently in recent years. In the world, problems related to food quality and safety, such as the mad cow disease in the UK, the Belgian dioxin contamination, the foot-and-mouth disease in Europe, the bird flu in Asia, etc., not only cause harms or pose potential threats to the physical and mental health of people, but also result in huge economic losses of consumers and related industries. In China, issues concerning food quality and safety also become increasingly prominent. Food quality and safety incidents of Jinhua ham, Longkou Vermicelli in Shandong province, Fuyang inferior milk powder, Sanlu melamine-tainted milk powder, etc., greatly undermine the consumers' confidences. Thus, how to improve food quality and safety level has become one of the focuses of the world.

In an industry chain, a symbiotic interdependent relationship exists between upstream and downstream enterprises that cater for certain specific demands or deliver certain products (or services)<sup>[1]</sup>. The agricultural industry chain management is a process in which the segments, such as the supply of agricultural means of production, the production, processing, storage and transport of agricultural products, etc., are linked together as an organic whole, and factors of people, money, materials, information, skills, etc., are organized, coordinated and controlled, to achieve added value<sup>[2]</sup>. As an advanced management model, industry chain management is more effective due to the fact that all segments of the production process are linked together as an organic whole.

In this paper, we attempt to analyze the food industry chain and build a food quality and safety management system for the chain to improve the level of food quality and safety.

## QUALITY AND SAFETY OF FOOD AND THE FOOD INDUSTRY CHAIN

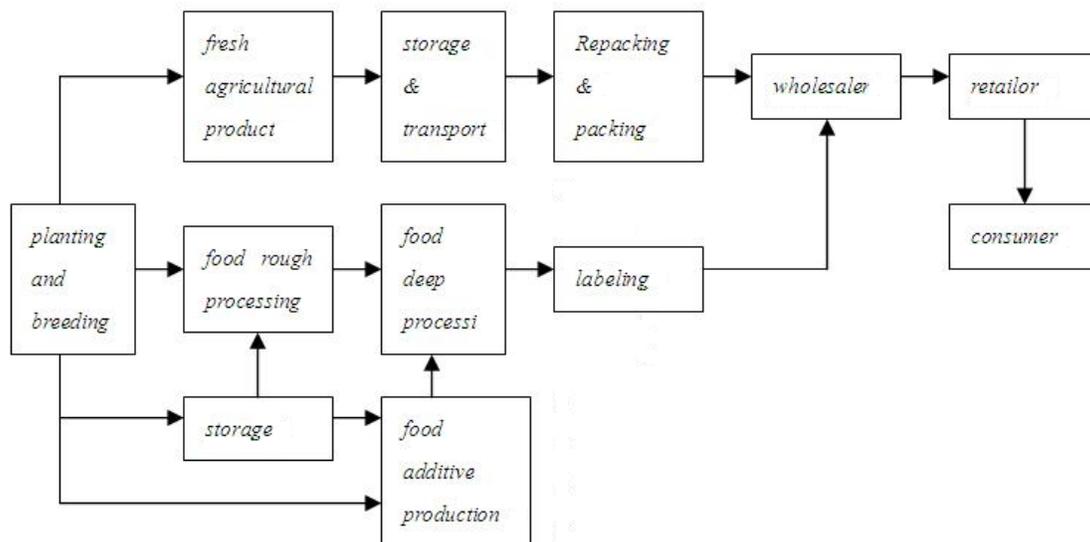
### Food quality and safety

Discussions of quality are always controversial: to define quality, we are influenced by both subjective factors of cultural, economic, philosophical, moral aspects, etc., and objective factors including the standardization of organoleptic and physicochemical properties, as well as food safety assurance<sup>[3]</sup>. "Food quality" can be defined in terms of the properties of the food and the extent to which it satisfies the consumers<sup>[4]</sup>. And three aspects are involved: (1) Food properties, e.g. all its inherent, distinct features, including extrinsic characteristics: shape, size, color, etc.; intrinsic characteristics: mouth-feel, purity, etc.; applicability: range of application, way to eat, conditions of use, etc.; quality characteristics: nutrition facts, shelf-life, the content of harmful and poisonous substance, etc.; (2) Expectations and requirements of consumer and the society for the food; (3) The satisfaction degree of the food consumer, e.g. satisfying of the explicit and implicit requirements for the food. The food quality can be measure through sensory analysis, instrument detection, food label, quality certification, food brands and enterprise brand, etc. Summarizing the majority of the scholars' points of view, Wu points out that food safety, or food quality and safety, means the food should not contain poisonous and harmful substances or factors that will injure or threaten human health, lead to acute or chronic poisoning of the consumers, or endanger the consumers' or their offspring's health. In the Codex Alimentarius, the definition of food safety is "assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use"<sup>[5]</sup>. Holleran, Bredahl and Zaubert argue that: "if safety-related specifications are included in the quality assurance system, then the assurance of quality encompasses safety."<sup>[6]</sup>

### Food industry chain

Different industries, including industrial, commercial, and agriculture sectors, etc., are involved in the food industry chain that not only refers to the material relations among all these industries: the process from the planting and the breeding industry supplying raw materials to food processing, to agricultural product acquisition, processing, storage, transportation, wholesale and retail, then to consumer's buying, but also refers to the organizational interfaces of these industries: the interrelationship between the organizations and the economic entities, such as the farmers, the specialized cooperative economic organization, food processing enterprises, wholesalers, retailers and

the distribution centers, etc. It means food industry chain is about the symbiotic interdependent relationships existing among upstream and downstream enterprises that cater for certain specific demands or deliver certain products (or services). And the economic entities and the organizations (e.g. the farmers, the specialized cooperative economic organization, food processing enterprises, wholesalers, retailers, etc.) become nodes in the chain. We can see the food industry chain covers the whole process from food production to final consumption. Based on the amount of segments in the industry chain organization, the food industry chain can be classified into long food industry chain and short food industry chain. Those food industry chain organizations having multiple segments, in which activities include agricultural materials supplying (e.g. seeds, fertilizers, pesticides, etc.) before the agricultural production, the agricultural production (planting and breeding), food processing, storage, wholesale, retail, are long food industry chains. While, food industry chains having only two segments of production and marketing are short industry chain types. Some agricultural products are sold directly to consumers in the market, involving only two activities of production and sale in the industry chain organization. Based on the consumers' different specific requirements for the food production and the biological characteristics differences of the food (agricultural products), combining the current situation of food industry chain in China, the food industry chain can be classified into the following types (as shown in Figure 1):



**Figure 1 : The general form of food industry chain**

The additives produced may be sold to the consumer directly at retail, or become accessories to food deep processing. Due to different development degrees of the industry chains and the different producing characteristics of specific foods, the food industry chain may have multiple forms. Hence, the above classification is only a general division of its common existing forms. And a specific food industry chain may be different from one of the above four forms.

### **Food industry chain and food quality and safety**

The food quality and safety issue exists throughout the food industry chain. To provide safe, healthy and nutritious food for consumers is a shared responsibility of all participants in the process from the beginning to the end production as well as the consumers' buying in the industry chain. Therefore, food quality and safety management should not be confined to the monitoring of single industry chain nodes or the final products, but the whole chain containing all participating nodes. If only the final product are being monitored, it is always difficult to take remedial action on the occurrence of food quality and safety problems resulting in the waste of resources and low efficiency of production. In case no quality and safety problem has been detected, there are two possibilities: first, the food which is safe, healthy and nutritious can meet the requirements of the consumers; second, the potential risks of

food quality and safety problems have not been detected due to the backward detecting methods or the imperfect monitoring system, which will finally hurts the interests of consumers. However, we can take the whole industry chain into consideration with all agents participating in food production accounting for quality and safety management. If potential dangers or quality and safety problems are detected on a certain node, rectification and reformation can be carried out on this node without risking the whole industry chain or the final product quality and safety.

## **FOOD QUALITY AND SAFETY MANAGEMENT SYSTEM CONSTRUCTION BASED ON INDUSTRY CHAIN**

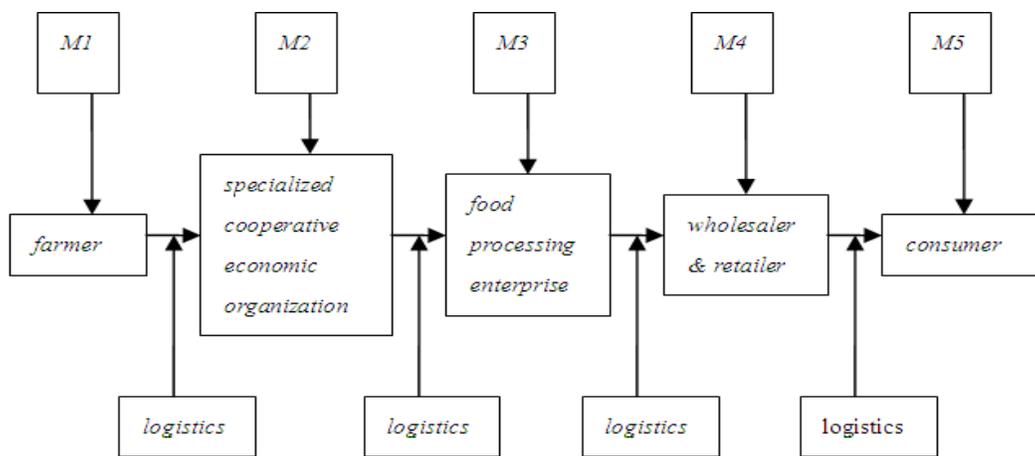
Food industry chain exists objectively in China. Whether the food can safely be transmitted from the production source to consumers depends on the behavioral agents in the whole chain. To provide safe, healthy and nutritious food for consumers is a common responsibility of all behavioral agents in the industry chain. Therefore, food quality and safety managements are needed throughout the whole industry chain, and each behavioral agent (or the node) in the chain is a decision maker and executor of the management task. However, the nodes in the food industry chain are loosely connected; the chain is not mature and its development has been relatively lagging behind; the industry chain-based food quality and safety management level is low and inferior to developed countries, and it is hard to eliminate this gap in a short time. Hence, it is a gradual process to realize quality and safety management of the food industry chain. To be safe, efficient, mature, healthy and nutritious is the development direction of food industry chain in the future, which will be detoured due to a lack of proper guidance for quality and safety management, and cannot satisfy consumers' increasing requirements for safe, healthy and nutritious food. For that reason, based on the food industry chain, two quality and safety management system (hereafter referred to as system-1 and system-2) are constructed in this paper.

### **The construction of food quality and safety management system-1 based on food industry chain**

Suppose a food industry chain assumes the following form; and the farmers, the specialized cooperative economic organization, food processing enterprises, wholesalers, retailers and the consumers are the industry chain nodes that are linked together via logistics, information, funds, and contract, etc.(as shown in Figure 2). Each node is a behavioral agent of the quality and safety management and performs its own functions. They jointly fulfill the obligations of food safety and quality management.  $M_i$  ( $i=1, 2, 3, 4, 5$ ) is the management tasks performed by the  $i^{\text{th}}$  node of the industry chain based on its own business. It is worth noting that though their functions in guaranteeing food quality and safety have not been reflected in Figure 2, government executive branches (e.g. organizations of food inspection and quarantine) occupy an important position in the food quality and safety management system. The important roles they play in guaranteeing food quality and safety mainly include: (1) The setting up of national food quality and safety standards, e.g. the Hazard Analysis and Critical Control Point (HACCP) system; (2) Concerning the determination of the technology development trend or the ethical and moral issues (e.g. the transgenic technology) of national health-related agricultural products, government policy plays a decisive role; (3)The construction of public infrastructures to improve hardware environment for agricultural products circulation; (4)Ensuring the availability of indispensable food items for life; (5) Performing food quality and safety management tasks, and providing inspection and quarantine services.

To have a clearer understanding of the quality and safety management activities of each behavioral agent (the executive branch of the government or the industry chain node), the  $M_i$  module is further divided in this paper deriving a reference paradigm (e.g. quality and safety management processes) for food quality and safety management performed by executive branches of the government and industry chain nodes. The main contents of reference paradigm include: (1) In case the behavioral agents want to improve the food quality and safety condition or maintain it at a certain level where the interests of the consumers can be protected, evaluate the risks facing food quality and safety management and make quantitative or qualitative risk descriptions;(2) Based on the risk descriptions, the behavioral agents will make risk management decisions that ensures a specific consumer protection

level; (3) Set a quality and safety management goal if needed;(4) Check whether the goal of food quality and safety can be achieved technologically, after the adoption of the control methods, such as HACCP (Hazard analysis and critical control points);(5) If the goal can be achieved, we need to determine the essential characteristics of the product/process, e.g. the performance standards or the process standards; if not, we need to make modification of the product/process for the purpose of achieving the goal technically, or abolish the product/process;(6)Control the products and the process using methods of HACCP, etc.; and also take the process variability and the setting-up of monitoring/confirmation procedure into account; (7) According to the food quality and safety goal, set the microbiological criteria. In case of changes of the internal and external environment facing the behavioral agents, we need to reevaluate the food quality and safety goal. As for the management procedures after reevaluation, consult the above paradigm. If the behavioral agent is an executive branch of the government that manages the imported food quality and safety, to ensure them to have the same required level of quality and safety, it should check whether the imported foods meet the food quality and safety goal and the microbiological criteria, as well as whether the recognized HACCP system is adopted in their production.



**Figure 2 : Industry chain nodes and the brief description of quality and safety management**

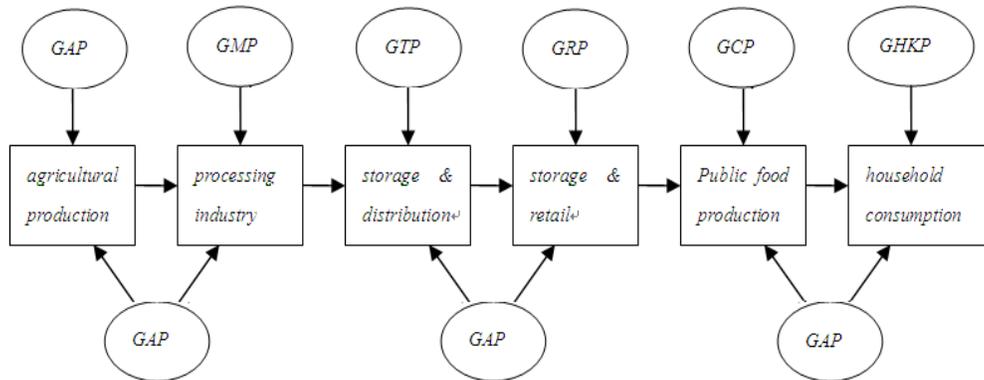
Since there are differences between the executive branch of the government and the industry chain node, and the industry chain nodes are also different from each other, the above management processes can only be regarded as a reference paradigm of behavioral agents' quality and safety management. Due to the reason that different food industry chain are in different stages of development, and the behavioral agents also have their own specific characteristics and play different roles in the industry chain, the formulation and implementation of food quality and safety management decisions made by the behavioral agents may not be in strict accordance with the paradigm. But this does not affect its values and functions as the reference paradigm of food quality and safety management.

At the primary stage of the food industry chain, when there is not a complete and scientific food quality and safety management operating standard in the behavioral agent-related industries (or the agent itself), system-1 has relatively more reference values and plays an important role in strengthening the quality and safety management of the food industry chain, as well as in improving the level of food quality and safety. In this system, the food monitoring performed by the executive branch of government, and the industry chain's self-management aiming to improve the food quality and safety level are emphasized; and the quality and safety self-management level of each node is determined by the awareness and willingness of this node, resulting in a gradual process of industry chain-based food quality and safety management.

**The construction of food quality and safety management system-2 based on food industry chain**

When the food industry chain develops into a mature stage, all behavioral agents, as well as their related industries, will formulate a set of scientific quality and safety management standards; will be

fully aware of the importance of food quality and safety; and will have strong willingness for quality and safety self-management. In some developed countries, the quality and safety management for the food industry chain has entered into such a stage. We build system-2 based on the managerial experience in developed countries (as shown in Figure 3)<sup>[9]</sup>. In system-2, each industry node will have one or more corresponding good practices (GP) of quality and safety management. Thus, each nodes only have to follow the good practice corresponding to it in performing quality and safety management.



**Figure 3 : Industry chain-based food quality and safety management and the relevant good practice**

GAP-Good Agricultural Practices  
 GLP-Good Laboratory Practice  
 GMP-Good Manufacturing Practice  
 GTP-Good Transportation Practice  
 GSP-Good Storage Practice  
 GRP-Good Retail Practice  
 GCP-Good consumption Practice  
 GHP-Good Hygienic Practice  
 GHKP-Good Housekeeping Practice

It is worth noting that system-1 and system-2 are not isolated from each other, but are closely related. At the relatively primary stage of the food industry chain when industries related with the behavioral agents (or itself) have not formulated complete and scientific quality and safety management standards, system-1 is more appropriate. At a relatively mature stage of the food industry chain when all behavioral agents have formulated complete and scientific quality and safety management standards, system-2 is more appropriate. Since the development of food industry chain are in a transition from the primary stage to a higher, and more mature stage, the food quality and safety management models vary<sup>[10]</sup>. Therefore, in practice, system-1 and system-2 coexist. Drawing references from system-1 and system-2, each behavioral agent can explore a food quality and safety management model suits itself best. The quality and safety management level of the behavioral agents in the food industry chain directly determines whether the final products can satisfy consumers' requirement for safe, healthy and nutritious food. The quality and safety level of the final product is limited by the behavioral agents with the lowest quality and safety management ability. Therefore, to achieve the food quality and safety goal calls for the collaborative efforts of all behavioral agents (including the executive branch of the government). For example, we can strengthen the management of the organization chain, the logistics chain, the information chain and the value chain by integrating the industry chains, thereby making the nodes more closely connected and promoting smooth and efficient operation of the industry chain. Then the goal of improving the food quality and safety level can be achieved.

## CONCLUSIONS

The objective existence of food industry chain makes it possible to perform food quality and safety management based on the whole chain. The behavioral agents in the industry chain manage their own businesses and activities according to the corresponding quality and safety standards, which is the

foundation of food quality and safety management. The final product quality and safety is determined by the cooperation of all the nodes (or behavioral agents) in the whole chain, as well as whether the management tasks are performed with the whole chain taking into account instead of single behavioral agent.

(1) Food quality and safety management is not only the responsibility of some executive branches of the government, or is confined to the monitoring of final products, but the common responsibility of all behavioral agents in the food industry chain. Each behavioral agents should do its part to guarantee food quality and safety, indicating that certain executive branches of the government and industry chain nodes should jointly perform food quality and safety management.

(2) Due to industry chain nodes' awareness degree of the food safety's importance, as well as the difference of their willingness for food quality and safety management, the industry chain-based food quality and safety management is a gradual process. The industries of the chain nodes (or itself) should formulate as soon as possible the scientific and normative food quality and safety management standards which are the foundations of industry chain nodes' quality and safety management activities.

(3) Two industry chain-based food quality and safety management systems are constructed in this paper, which are not isolated, but closely related. In the gradual development process of the food industry chains in China, the industry chain-based food quality and safety management can draw references from both system-1 and system-2, which jointly provide reference paradigms and guiding ideologies for each behavioral agents in carrying out quality and safety management.

(4) Some executive branches of the government play important roles in ensuring the food quality and safety. Industry chain-based food quality and safety management requires the government to formulate or introduce advanced and scientific food quality and safety assurance standards; and the relevant executive branches of the government to be strict in monitoring food quality and safety, thereby keeping fake and shoddy foods out of the market.

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