Food Safety Regulation and Private Standards in China

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Abstract

Both global and domestic markets place increasing importance on the quality and safety of food products produced in China. The presence of microbial agents, toxic animal or plant products, and chemical contamination are major food safety problems. Suppliers to export markets face relatively high refusal rates for Chinese food products. We provide an overview of food safety problems in China and the changes and efforts made by the government and private sector to meet the needs for improved food safety. Evidence from the vegetables and vegetable processing sector illustrate the challenges in developing a coordinated quality and food safety system and the advantages that larger scale firms and integrated supply chains hold in competing in high quality markets. Both the lack of testing and inability to control hazards as they enter the food distribution system lead to systemic failures in the food production system. Current efforts are directed to developing supply networks to assure safe production practices among suppliers, and investing in greater control of products and traceability in the supply system. Challenges center on problems of (1) coordination and enforcement of food safety regulations, (2) implementing traceability in the agricultural and food product system, (3) lack of public confidence in the safety of the food supply, and (4) the high cost of implementing food safety controls. Improving technical standards at each stage throughout the supply chain and integrating the entire process requires attention to

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demonstration, training and consultative services, as well as investment in infrastructure, testing, and systems of tracking ingredients and product. Establishing and comprehensively enforcing a unified legal and regulatory food safety system in China would provide the foundation to maintaining quality and food safety in both domestic and export markets.

Keywords
Food safety • China • Food quality • Fresh and processed vegetables • Supply chains

9.1 Introduction

China's rapid urbanization and modernization that accompanied rapid economic development, major demographic shifts of population from rural to urban areas, and growing importance in international markets for food and agricultural products have had major effects on its food supply and food safety. Along with the growth in income, per capita consumption of meat, fish, and oil products have increased rapidly. At the same time, China has become a leading exporter of vegetables, fruit, livestock and poultry products, and fish and shrimp products. As shown in Figs. 9.1 and 9.2, vegetables and aquatic products lead other agricultural products in export volume and value and both have risen rapidly since 2000.

The increased demand for food and agricultural products from China has put pressure on the food supply networks to meet demand, through both local supply and increasingly industrialized supply chains. Both global and domestic Chinese markets place increasing importance on the quality and safety of food products produced in China, in part due to experiences with major food safety problems. Recent examples include the melamine contamination of infant milk powder in 2008; toxic pesticide residues detected in cowpeas in Hainan Province in 2010; and the 2009 discovery of the use of ractopamine, a prohibited substance in China, in pig production (Wang et al. 2008; Zhou and Yue 2010; Jia et al. 2012; Lam et al. 2013). The presence of heavy metals, poor sanitation, overuse and misuse of fertilizers and pesticides, and use of illegal chemicals and food additives have affected the water supply and safety of food products, and has led to mistrust among consumers (Calvin et al. 2006; Dong and Jensen 2007; Lam et al. 2013).

In this chapter we provide an overview of food safety problems in China and the regulatory changes and efforts of private suppliers to meet the needs for improved food safety. We provide several examples from recent case studies to illustrate the increased efforts in private supply chains to maintain tighter control of products and traceability in the supply system. Finally, we summarize the types of changes required by public and private agents to enhance the food system and respond to the potential for food safety failures.

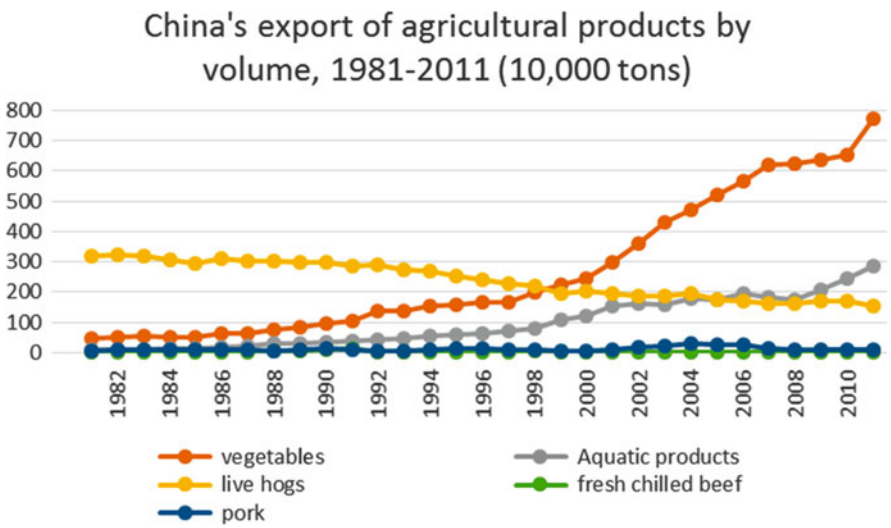

Fig. 9.1 China's export of agricultural products by volume, 1981–2011. *Source*: National Bureau of Statistics of China (2012), Department of Rural and Social Economic Survey of National Bureau of Statistics of China (2012), Ministry of Agriculture (2011, 2012)

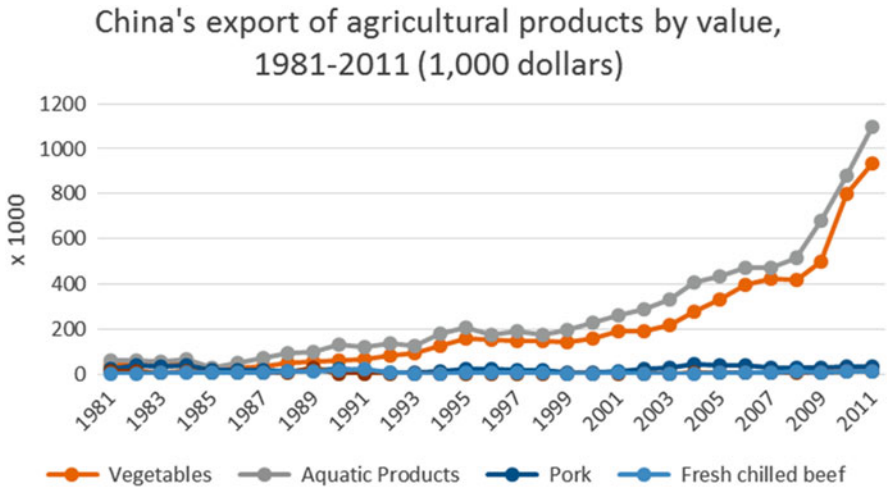

Fig. 9.2 China's export of agricultural products by value, 1981–2011. *Source*: National Bureau of Statistics of China (2012), Department of Rural and Social Economic Survey of National Bureau of Statistics of China (2012), Ministry of Agriculture (2011, 2012)

9.2 Food Safety Issues in China

China's food system has emerged from one focused on problems of famine and insufficient supply, to one that now produces large quantities of processed foods destined for export markets, as well as dairy, pork, poultry, and aquaculture to meet the growing demand for animal source foods. China's growing middle class—expected to grow from 247 million in 2012 to 607 million in 2020—has fueled demand for increased meat and dairy products, as well as readily available fresh produce in urban markets. Along with the increase in production, rapid urbanization and new food marketing networks have disrupted traditional institutions and trade and introduced the potential for greater spread of contamination and food safety problems in the system. Despite government efforts, food safety in marketed foods is a growing problem, and the potential for failures has outpaced the government's ability to control the problems, especially in domestic markets. Consumers, therefore, lack confidence in the safety of domestically produced food.

Recent reports of food safety problems in China list microbial agents, toxic animal or plant products, and chemical contamination as the three major types of food safety problems, with microbial contamination most frequently reported (Lam et al. 2013). In addition, food safety issues pose problems for China's increasing exports of food products as importing regions in the European Union, Japan, and the United States have relatively high refusal rates for Chinese food products (Dong and Jensen 2007; Zhou et al. 2013b).

One of China's major challenges to providing safer food is the sheer number of farmers and food producers in the agricultural sector. Many operate as small-scale producers, and some farmers lack training in the safe use of chemical fertilizers, pesticides, and food production practices (Calvin et al. 2006; Dong and Jensen 2007; Zhou and Yue 2010; Zhou et al. 2013a). Without adequate training and use of safe practices, and without adequate tracking systems to link problems to specific farm producers, some farmers can send products to food distribution channels with high residue levels of feed additives, toxic chemicals and other contaminants, and microbial contamination. However, the ability to detect and control food safety problems is limited by the fragmented marketing system, the number of small-volume cash exchanges that occur, and limited testing of product quality (Calvin et al. 2006; Huang et al. 2009; Gale and Hu 2012).

A lack of testing and an inability to control hazards as they enter the food distribution system lead to systemic failures in the food production system. The failures arise from the inherent nature of the untraced contamination and mixing that can occur as food and food ingredients are processed and distributed within the food system (Hennessy et al. 2003). In response, the Chinese government and food industry have promoted vertically coordinated supply channels, improved traceability, and improved testing and auditing, which offer greater control of products and reduce the potential for losses that might spread through the food system without greater controls.

Since the 1980s, various supply network models have emerged, including relatively tightly controlled vertically integrated farming organizations that may

lease land and hire labor, "company plus farmer" models that involve production contracting with farmers and may include specifications for inputs and other variations that strengthen backward linkages between retailers and producers (Gale and Hu 2012). Government and industry have encouraged increased control of supply networks in order to enhance available information about production, processing, and handling of products that enter retail and export channels. However, in practice, the control of food safety problems in the widely diverse and fragmented production, processing, and handling systems remains a significant problem. Efforts to better organize the supply networks and contracting offer some prospects for standardization of production practices among the large number of small producers.

9.3 Regulatory Context and Government Initiatives

In the last 25 years, China has introduced various product certification standards, test methods, and measures that are aligned with international practice and in compliance with the requirements of the World Trade Organization (WTO) rules. In addition to improving food safety in domestic markets, the standards and regulations are designed to promote safety of products that enter export markets. Since the late 1980s, the major food safety legislation has included the implementation of the *Standardization Law of the People's Republic of China* (1988), a major revision to the *Food Hygiene Ordinance* (1995), the new *Agricultural Product Quality Safety Law of the People's Republic of China* (2006) that regulates agricultural products, the comprehensive *Food Safety Law of the People's Republic of China*, and the *Implementation Rules of Food Safety Law* (2009) (Lam et al. 2013). These laws form the basis of China's technical trading and measurement system, and are designed to harmonize China's food safety system with international standards. The 2009 Food Safety Law establishes that food safety is both a public and private responsibility.

Recent efforts have focused on institutional reforms to better integrate regulations on food safety across the food supply system. This effort has involved merging the oversight of food safety from state administration for industry and commerce in various governmental offices and bureaus (e.g., food safety office, food and drug supervision bureau, production stage of quality inspection bureau, distribution stage in market regulation) into the China Food and Drug Administration (CFDA), in order to better coordinate and lead in the government regulation of food safety throughout the whole food supply system. Among its main responsibilities, the CDFA charts laws, regulations and rules coordinated with efforts by food companies and local governments ("integrated responsibility"). The CFDA also has responsibility for coordinating food safety information, standards and risk monitoring. Although it is still early, the new efforts to coordinate food safety control in a single agency has introduced a new era of safety and quality inspection and supervision for agricultural products and foods for both domestic and international markets.

Table 9.1 Traceability demonstration cities in meat and vegetable production

Year	Number	Cities
2010	10	Shanghai, Chongqing, Dalian, Qingdao, Ningbo, Nanjing, Hangzhou, Chengdu, Kunming, Wuxi
2011	10	Tianjin, Shijiazhuang, Harbin, Hefei, Nanchuang, Qinan, Haikou, Lanzhou, Yinchuan, Urumqi
2012	15	Beijing, Taiyuan, Hohhot, Changchun, Zhengzhou, Changsha, Nanning, Guiyang, Xi'an, Xining, Suzhou, Wuhu, Weifang, Yichuan, Mianyang

Among other changes, the Chinese government initiated programs for traceability in the agricultural supply chain from farm gate to retail in several relatively well-developed areas (e.g., across China's developed coastal areas, especially Zhejiang Province and Shanghai City).[1] These programs, initiated in 2002, were designed to support the safety and quality of agricultural products in international and domestic markets. Efforts include the introduction of improved documentation of production methods, building effective traceability systems, monitoring and providing information on product qualities, supporting local systems in marketing management for vegetable and livestock production, and construction of national agricultural standardization demonstration gardens to cover all sectors in agriculture. In 2012, there were more than 4,000 demonstration gardens throughout the country. In addition, since 2010, the government has introduced traceability demonstration systems that provide traceability information to consumers in meat and vegetables markets in the selected demonstration cities (Table 9.1).

These changes have led to significant progress in improved food product quality and reduced food safety problems. As an example, over 40 agricultural products from Zhejiang Province were authenticated and included in the first batch certifications of pollution-free agricultural products in the country (Ministry of Agriculture 2003). Today, nearly 4,000 products have been certified, with pollution-free quality verified through spot-checks in Zhejiang Province to meet the national levels for certification (Hangzhou Center for Inspection and Testing for Quality and Safety of Agricultural and GM Products 2013). Although evidence from other areas suggests continuing problems for certification and testing (Huang et al. 2009), the progress in Zhejiang Province indicates progress in achieving product certifications on production practices.

[1] Several of China's laws, legislations, and rules related to food traceability are summarized in Law of the People's Republic of China on Quality and Safety of Agricultural Products (2006), The Administrative measures for the Packaging and Marking of Agricultural Products (2006), Food Safety Law (2009), and Management Regulations on Live Pig Slaughter (2010).

9.4 Challenges for Food Safety Control

Despite the country's progress, problems persist in making China's current agricultural product-quality traceability system consistent with the requirements for achieving comprehensive food safety standards. The current challenges center on problems of (1) coordination and enforcement of food safety regulations, (2) implementing traceability in the agricultural and food product system, (3) lack of public confidence in the safety of the food supply, and (4) the cost of implementing food safety controls. First, the coordination and enforcement of food safety regulations are inadequate to meet the needs for integrating food safety regulations across governmental departments and within a system of many widely dispersed agricultural producers. The sector includes over 200 million farmer-households producing on 1–2 acres of land on often non-contiguous plots (Calvin et al. 2006; Jia and Huang 2011). Efficiency of the entire supervision of food safety is relatively low, and the legal and regulatory enforcement is not sufficient to hold producers and processor accountable for food safety failures (Li 2011). Greater attention to a more unified agricultural product certification would support better integration of the standards throughout the food system and emphasize the importance of private sector involvement and coordination with public efforts to manage food safety risks.

Second, efforts to implement a system of traceability in the food system are limited by the fact that production documents and distribution marks are not well integrated within the agricultural and food supply chain. The large number of small-sized agricultural producers and widely dispersed farmer-suppliers have little training related to adhering to food safety controls (Zhou and Jiang 2007; Huang et al. 2009; Li and Kou 2010). Although the process for tracing products and ingredients back to the farm or supplier is available, the lack of universally recognized barcodes or quick response (QR) codes causes difficulties when trying to trace the source of food safety or quality problems. The ability to trace and recall products is especially important for high-risk foods (such as dairy products, infant formula, etc.). Furthermore, non-food raw materials and additives used in food production are not well monitored.

Third, public confidence in food safety is low. Lack of public access to information about product sources and processing (as through adequate information on product traceability) (Gu and An 2012) and about failures in government testing has led to low public trust in the food industry, despite government involvement and oversight.

Fourth, because of the traceability and information problems, the market system does not "reward" (provide the needed premiums) for the higher costs of taking more cautions and supervising food quality/safety by producers, processors, and other suppliers in the food system (Shi and Zhou 2012), although certifications may provide access to export markets. Based on results from a survey of food exporting enterprises, Chen and Song (2009) report that following the adoption of the new food safety law, the firms faced increased inspections, higher costs of inspections, training, record-keeping and recall costs. Costs for improving infrastructure required for implementing various quality management programs (including

HACCP, GMP, GAP ISO9001, ISO14001 and ISO22000[2]) increased significantly from 2006 and 2007. They estimated that the overall costs of compliance for the surveyed export-oriented firms by 2008 were 4.7 % of total sales and 6.2 % of the total export costs. Zheng et al. (2013) report that ISO 22000 is the most widely used of Third Party Certifications (TPC) in China and find that TPC would lead to positive gains in trade by China's exporting firms with trade to the United States. China's ISO 22000 standards for food safety management have increased rapidly, from 369 certificates in 2008 to 8,228 certificates in 2012.

The relatively high costs of implementing traceability systems along the supply chain due to labor required for documentation and capital for information systems may be the main reason that the firms with traceability systems do not benefit from the market through higher prices, especially in domestic markets. Without adequate premiums for caretaking, the domestic market does not reward the higher costs of supervision of these food market activities. However, the firms may gain access to export markets.

Key to assuring the quality and safety of agricultural products is the ability to control food safety and quality throughout the food supply system. Important tools in the process are achieving some degree of agricultural standardization, supporting existing agri-product voluntary certification programs (pollution-free, green, and organic certifications), and further development of the agricultural product traceability system. Certification of pollution-free agricultural products, products containing only limited artificial fertilizers or chemicals, is issued by the Ministry of Agriculture and the national Certification and Accreditation Administration, and is the first level of product certification. It is used widely across China. In 2007, about 10 % of agricultural products available were certified as pollution-free, and another 4 % had either green or organic certification.

By 2012, these figures had increased to nearly 76,000 agri-products certified as pollution-free, 16,929 certified as green, 1,916 certified as organic, and 1,001 certified as Geographically Identified (GI). These products accounted for the production from over 47 % of China's total arable land (Xinhua.net 2012). Although pollution-free certification is voluntary, government subsidies encourage the certification, and the intent is that all agri-food from China will reach the status of pollution-free product in the next several years.

Certification of quality and safety standards, including input usage or production practices, has been a successful method of improving quality control in the food supply chain in many countries. Although the application and enforcement of food safety and quality standards has limited ability to *guarantee* that products on the market are safe and of high quality, the standards serve as a mechanism for communicating information in trade and reducing uncertainty about products and process attributes between buyers and sellers.

[2] Hazard Analysis Critical Control Point (HACCP) systems, Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP); ISO standards are set by the International Organization for Standards as guidelines for quality assurance by suppliers (ISO9001), for environmental management systems (ISO14001), and for food safety management (ISO22000).

Efforts to develop supply networks, agricultural cooperatives, and contractual arrangements offer some prospects for facilitating the adoption of food safety and quality standards to improve the quality of foods offered to domestic and export markets.

9.5 China's Agricultural Cooperatives and Contractual Arrangements

Despite the extensive regulatory reforms, the assurance of a safe and high quality food market is difficult to achieve due to a lack of standardized production practices and relatively little vertical coordination. Most small-scale farmers cannot afford the costs of implementing the standardized practices. In addition, some farmers are not well educated and do not understand the requirements for standardized production practices that can assure safer foods (Jin and Zhou 2011). This leads to problems of improper and excessive use of pesticides and fertilizers, use of illegal chemicals and food additives, and poor sanitation practices.

Farmer cooperatives in China offer a structure through which formal and informal agreements can be made between farmers and buyers. These arrangements support vertical coordination that can better address food safety and quality concerns. A recent study by Jia and Huang (2011) investigated the contractual arrangements of farmer cooperatives through a national survey (conducted in 2003 and 2009) and found that over half of the farmer cooperatives used contracted marketing in their primary marketing channel. The basis of the contracts was, more often than not, commitment for market delivery, and much less often quality and farming practices. The contracts were of both written and oral form, with written ones occurring more often in the more modern supply chains and when the farmer cooperatives had their private brand. Most of the farmer cooperatives were in the sectors for cash crops and livestock products. However, commitment to meet *public* food safety and quality standards was not an important component of contracting arrangements between farmer cooperatives and buyers (Jia and Huang 2011), and control of products throughout the food supply system remained a challenge.

Improved standardization of production practices used by farmers is important to achieving safer foods. Agricultural cooperatives provide both a larger scale of "production base" to share related costs as well providing a way to organize production practices. Jin and Zhou (2011) found that among the vegetable cooperatives in Zhejiang Province studied, larger cooperatives (approximated by land area), those with a more positive attitude about food quality and safety standards, and those owning a brand name were more likely to adopt standards. At the same time, an agricultural cooperative's access to destination markets—both supermarkets and foreign markets—is enhanced by adoption of food quality and safety standards. As the development of supermarkets and chain store retailers improves, farmer cooperatives will be encouraged to adopt food quality and safety standards.

Some examples drawn from the vegetable industries illustrate the challenges of assuring food safety and quality in the food supply chain, and factors that influence the adoption of standards and practices related to food market systems today. Both government and industry are making efforts to address the problems.

9.6 Case Example: Vegetables

The Chinese vegetable industry is a major supplier to both the large domestic market and increasingly to the world vegetable market. The value of exports of vegetables ranks second behind aquatic products today, and has risen dramatically since 1990—nearly twice the rate of aquatic products (Fig. 9.2). Much of China's vegetable production comes from Zhejiang Province, located on the southeast coast of China. The vegetable production and processing industry is one of the most important agricultural industries in Zhejiang Province. During the last decade, the Chinese government has identified priority enterprises likely to survive market competition in export. Many of these "flagship firms" in the vegetable sector are located in Zhejiang Province, which is ranked third in the export value of vegetables. Hence, compared with vegetable processing firms in other provinces, those in Zhejiang are relatively more export-oriented and oriented to producing products with a higher level of food safety. Thus, examples from Zhejiang Province provide insight into the ways in which private and public efforts can work to meet the needs for food safety.

China's vegetable industry faces increased scrutiny on food safety and quality standards in its export markets. As the vegetable sector has grown, so too have related food safety issues associated with increased application of agricultural chemicals, heavy metals, and other hazards introduced through fertilizers or water supplies. The presence of residues from highly toxic pesticides are a particular problem as pesticide residues pose a risk to both the health of China's consumers as well as in export markets. Exporting firms have faced relatively high refusal rates in exports to major destinations such Japan, the European Union, and the United States.

A recent survey of 507 vegetable farmers found that almost one-quarter of farmers interviewed (23.0 %) used highly toxic pesticides compared to those using less toxic methods (Zhou and Jin 2009). Almost all of the farmers (91.7 %) farmed plots of land less than 1 ha. Those using highly toxic pesticides were older and less educated farmers. In addition, those who were not specialized in any vegetable crop and those who tended to have higher rates of self-consumption were more likely to use highly toxic pesticides. Over 60 % (62 %) of farmers who did not apply highly toxic chemicals were members of an agricultural cooperative, compared to the 37 % cooperative membership rate of those that did. Farmers who were not using toxic chemicals were more likely to sell their produce in wholesale markets or to agricultural processing firms instead of directly to handlers. Both the wholesale markets and processing firms are more likely to test for pesticides. The results suggest that basic knowledge about pesticide use and market orientation is

an important factor in the choice of methods at the farm level. In addition, better training and market organization (cooperative membership) are shown to support safer practices. Also, buyer testing of products was associated with safer production practices.

A survey of vegetable processing firms in Zhejiang Province was conducted at about the same time (2006–2007) (Zhou and Yue 2010; Zhou et al. 2011a). About 130 firms were ultimately used in the analyses. Pollution-free certification of products, and following ISO 9000 standards in processing—both voluntary practices—were the most common certifications. Among the processing firms, 47 % indicated they followed ISO 9000 standards (voluntary); about a third (35 %) used a HACCP system to control food safety risks (mandatory for frozen vegetables and voluntary for other products); and 36 % used quality control (QC) standards (mandatory for several categories of processing products) to assure quality and tests on food safety (Zhou et al. 2011a).

Zhou and Yue (2010) found that most firms adopt food safety and quality controls in order to improve product reputation and popularity (76.5 % of firms). Also, firms made investments in food safety and quality controls in order to enhance brand image and reputation and gain market access. However, for many of the firms, meeting government regulations provided the main incentive. In contrast, firms that sold into export markets were more likely to face requirements for production and processing records, and certification of the origin of the product; and also faced requirements for inspection of the production environment. Overall, only 28 % of the surveyed firms had product recall systems in place. Some of the other firms had staff in place to help in handling product traceability. The formal recall systems were more common among urban and export-oriented firms. Firms indicated that they were most confident in raw-materials traceability when they sourced from a firm or cooperative, and least confident when sourcing raw-materials from individual farmers or from pooled raw-materials markets (spot markets or common procurement). Verification of the production environment and monitoring would be required for pollution-free or green certification.

Lack of timely delivery of product, inconsistent raw material quality, and low technical skills all limited the processing firms' ability to achieve control of product quality and safety. Firms identified out-of-date control technologies and lack of ability to take advantage of economies of scale as the major obstacles to achieving higher levels of product or management system certifications (e.g., HACCP). Firms targeting export markets were the larger-scale firms—firms able to gain from economies of scale in food quality and safety control.

Wholesale markets are a key link in the distribution of vegetables for the domestic market, and provide a good example of the difficulties of implementing controls for vegetable quality and safety through traceability systems. A recent study in cities in Zhejiang Province in 2009 highlights difficulties in incorporating traceability in the distribution channel at this key exchange point, and the need for coordination between the markets and government in managing the risks (Zhou et al. 2011b). Traceability is assured with information obtained as vegetables enter or leave the market. However, by this measure, the survey found that in the

city markets, only about one-third of the product is traceable (forward and backward). The markets suffer from structural and coordination issues. Regulatory authority is not well coordinated between public and private market management. Because of competitive pressures and lack of customer demand for tighter control, there is a relatively low level of compliance on quality and safety controls. The markets themselves do not generally enforce a registration system for admission to the market or registry for products leaving the market; do not regularly conduct product sampling of suppliers; and are lax in enforcement mechanisms for out-of-compliance sellers. However, more frequent government inspection was associated with suppliers implementing traceability systems.

Despite recent efforts to improve training of upstream producers in the areas of accountability and product safety management, these efforts have not been successful in helping suppliers understand the need for traceability and the need for quality and safety assurance. The lack of customer interest and awareness about food quality and safety traceability systems also limits incentives for maintaining tighter control of the distribution system. Incentives for suppliers implementing traceability systems were greatest for large-scale suppliers, who are likely to be able to achieve the economies of scale in implementation of the capital and data investment required, as well to see the longer term benefits of better management.

In efforts of shared responsibility for food safety control, the government of Zhejiang province has worked to support food safety-related infrastructure for agricultural and food firms. This includes the construction of a distribution traceability system to cover hog procurement and processing (including district markets), 3 wholesale markets, 30 fresh and chilled meat wholesaler, over 150 wet markets, 1,380 meat retailers, 50 supermarkets and nearly 2,000 restaurants and food service companies. The traceability system is designed to ensure effective transmission of information flow along whole supply chain and establish responsibility for food safety failures along the traceability system.

In further efforts, in 2012 Zhejiang province established an office of agricultural product quality and safety to supervise the product certifications. Under this supervision, 11 cities in Zhejiang province set up Green Food Offices for inspection and regulation of pollution-free and green products. These efforts were designed to provide more efficient certification for the private sector, including retail firms, processors, distributors and large farmers.

Other public and private support has come in the form of subsidies and support to the private sector for assistance in meeting standards, worker training, constructing demonstration sites and related social services to meet the agricultural and market standards. In addition to the special fund from the central government, Hangzhou city has provided nearly 50 million RMB ($8.23 million) to support the efforts for establishing the meat and vegetable traceability system, and additional resources to encourage private enterprises, firms and farmer's cooperatives to produce products certified as green food products (Farm Administration Bureau and Agricultural Quality and Safety Center of Zhejiang Province 2013).

9.7 Challenges Ahead and Recommendations

The food safety challenges that China faces today in both export and domestic markets reflect the need to improve technical standards throughout the food supply system. Although costs of production may seem to be low, the additional costs of assuring safe products and compliance for meeting international SPS and quality requirements are likely to be high. Evidence from the vegetables and vegetable processing sector illustrate the challenges in developing a coordinated food quality and safety system and the advantages that the larger scale firms and integrated supply chains hold in competing in high quality markets. Improving technical standards at each stage throughout the supply chain, and integrating the entire process will require attention to demonstrations, training, and consultative services, as well as investment in infrastructure, testing, and systems for tracking ingredients and products. Priority needs to be given to changes that limit market access to producers of quality and safe products through inspection of food products and non-food raw materials and documentation of additives used in food production. In addition, developing a legal and regulatory system to address food safety risks and clarify the laws, administrative regulations and rules, local regulations, and normative documents that delineate the responsibilities and purview of the associated regulatory bodies and private firms in meeting food safety objectives would help to address the challenges of China's relatively disperse food control system. Establishing and comprehensively enforcing such a system in China would provide the foundation to maintaining the quality and food safety in both domestic and export markets.

China is now making efforts to enact and strengthen laws aimed at monitoring high-risk foods through traceability systems, and to establish a recall process for unsafe food. Chinese regulators have built the relevant quality and safety management systems with early warning and rapid response mechanisms ensuring quality and safety for both export and import markets. However, more attention needs to be paid to the food and agricultural product certifications (pollution-free, green, and organic) that establish the quality of production, handling, processing, and distribution in the market. Agricultural firms and enterprises will be the major bodies to adopt or implement the certification systems, and in doing so, realize increased control in the area of food safety. The pollution-free, green, and organic product certifications have achieved important results to date.

China continues to make efforts to improve services and provide support to farms and distribution and transportation channels, and to establish competitive markets for quality agricultural products. Having a modern agricultural standards system constructed in a scientific and unified way, and in compliance with international standards, is especially important for major agricultural and food products.

China's lawmakers will need to encourage local governments and associations to establish local agricultural standards that are reasonably structured and consistent with national industry standards. In doing so, it will be important that the central and local government work together to establish agricultural product testing and inspection systems, including support for HACCP programs. These efforts should

be designed to strengthen quality control on food production through agricultural standardization. This may occur through a two-tiered approach, with increased incentives and monitoring supporting agricultural flagship firms and farmer cooperatives. In this way, the system encourages high-level firms and cooperatives with core competitive power and assigns other resources and regulatory activities to help bridge the gap between the market demands and the scattered and unskilled Chinese farmers.

Recent progress in food safety traceability has been limited by the high cost of establishing a traceability system in China. The high costs make it difficult to incentivize producers like farmers' cooperatives to adopt a voluntary traceability system without sufficient support from government and guidelines from associations. Firms seek quick returns and to maximize profits, which has several important implications.

First, in the process of agricultural modernization, the newly organized producers, such as farmer cooperatives and leadership firms, are in the best position to initiate the extension and demonstration program on methods for tracking back to scattered farmers. Such systems would document production, record the purchase and use of agricultural inputs, and provide quality tests for purchased agricultural products. The systems would require product barcodes, QR codes, product labels, and standardize recording at all stages to strengthen the monitoring of food safety. Such systems encourage producers to manage in a unified manner and provide uniform service to farmers, and can establish confidence in supply networks and achieve access to downstream markets. The challenge for this process is developing ways to coordinate the many small-scale producers and handlers in such a system. Agricultural cooperatives are likely to play an important role in achieving the scale needed for implementing the quality and safety control systems.

Second, industry support to policies that links modern farming methods with vertical integration operation of processors can allow achieving economies of scale required for food quality and safety traceability. The costs for establishing traceability systems could be shared with support from the local government via research and development (R&D) investment, financial subsidies, and technical consulting services.

Third, it will be necessary to strengthen communication and collaboration among governmental departments and better unify management by agencies for food safety under a single control. A unified agency function can better monitor incoming trade to the agricultural wholesale markets, and standardize common testing, certification, and other documents designed to safeguard food safety.

In these efforts, it will be important for the relevant agricultural regulatory bodies and industry associations to strengthen and promote the knowledge of quality and safety traceability in production, distribution, and consumption, and to actively participate in implementation of a traceability system throughout the food system. Increasing information about food safety traceability among the public will increase consumer awareness and encourage consumers to request certificates or invoices that document the food source. Such interest may translate into increased willingness to pay and willingness to purchase products with

traceability attributes, and thus encourage the traceability system implementation in China's agricultural product supply chain.

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