

China's dairy crisis: impacts, causes and policy implications for a sustainable dairy industry

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The dairy industry is an important part of the global economy, and the rapidly developing dairy enterprises in China have become increasingly important to the rest of the world. Due to increasing demand for dairy products and support from the government, China's dairy industry has thrived in recent decades. But rapid growth has been accompanied by a suite of industry/structural problems associated with raw milk supply, processing enterprises, product retailing and profit allocation. Thus, a major dairy crisis took place in 2008, triggered by a notorious melamine-contaminated milk event. The dairy crisis has had devastating impacts on China's dairy industry, negatively affecting farmers, consumers, processing enterprises and even government agencies. The Chinese government has developed rigorous measures to prevent future incidents of this sort, including the enactment of the Food Safety Law and reinstatement of the no-exemption quality inspection of food products. In this paper, we analyse the wide-ranging impacts and root causes of the recent dairy crisis in China. We also examine how the crisis has been handled and what measures have been put in place in its aftermath. Then we discuss policy implications for promoting the sustainability of China's dairy industry. Lessons learned from this crisis, as well as implications for policy improvements, should be valuable for the development of a sustainable dairy industry in other regions of the world.

Keywords: China; dairy crisis; sustainable dairy industry; dairy food safety; impacts; structure; measures

Introduction

The provision of adequate and safe food is a basic economic activity in any society (Swinbank 1993) and an essential prerequisite of any sustainable society. Thus, food safety is a global concern and has received increasing attention (Swinbank 1993). Dairy products are an important component of human diet. However, milk and related products are vulnerable to adulteration and bacterial contamination, and thus require sophisticated quality control mechanisms for the industry's supply line (Collins 1993). In China, the safety of dairy products has become a public concern in the aftermath of a serious outbreak of melamine poisoning of infants in 2008. The Sanlu group, based in Shijiazhuang, Hebei Province, one of China's largest dairy manufacturers, has been the main focus of this concern because its milk-based food products were found to be contaminated with melamine (Ni and Zeng 2009). Melamine, an industrial chemical often used in the manufacture of plastics, was added to milk to make the protein level appear higher than it actually was in order to deceive protein tests (China Daily 2008). The contaminated dairy products scandal led to the deaths of 6 infants and almost 300,000 babies became sick because of kidney problems caused by melamine (China Daily 2010). China's biggest dairy makers, including China Mengniu Dairy Co., Inner Mongolia Yili Industrial Group and Shanghai Guangming Dairy and Food Co., were also involved in this scandal, which resulted in a series of negative effects on China's

dairy industry – a crisis that has devastated many domestic dairy businesses throughout the country.

This dairy crisis not only paralysed dairy enterprises, but also had negative effects on consumers, dairy farmers and the government. The questions are, therefore, to what extent did this crisis affect dairy enterprises, and what are the root causes of the crisis? It is thought that a lack of laws and regulations in China may be the main reason for the nearly out-of-control problems of food safety in the country (China Daily 2005; Asian Development Bank (ADB) 2007). It is true that poor supervision, lack of standards and unscientific cattle-raising exist in China's dairy food production. However, as Collins (1993) pointed out, 'Economic factors were as important as the legislative and scientific in the raising of food standards'. Although many specific solutions to the issue of China's dairy food safety have been suggested, the key question is to determine and analyse root causes of the crisis and draw policy implications to help the dairy industry to survive. Lessons learned here should be helpful to dairy-producing regions around the world – especially in developing countries.

China's dairy industry has made a great progress since 1980, when dairy production was only about 1 million tons per year. During the following 15 years, the output increased steadily by about 14% annually. After the mid-1990s, however, there was a structural break (Fuller et al. 2006). Between 1997 and 2007, the growth of dairy production accelerated by more than 20% annually. Aggregate

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production rose to more than 35 million tons in 2007, a level that ranked China third in the world after the United States and India. Matching the growth of milk production, China's dairy cow herd also increased by 20% per year after 2000 (Fuller et al. 2006). By 2007, there were 12 million dairy cows in China. The rapid growth of the dairy industry in China is mainly driven by several mutually reinforcing factors: increasing dairy demand and support from the government and dairy firms (Qian and Guo 2007). The annual per capita milk consumption in China increased from 9.23 kg in 1992 to 24.87 kg in 2007 (Dairy Association of China 2008); the total output value of dairy firms increased from US\$1.7 billion to US\$18.6 billion. The Chinese dairy industry has a short history of less than 10 years, while it has taken Western countries decades to develop their dairy industries. Therefore, great risks and problems can occur in such a fast development process. The Sanlu contaminated milk scandal revealed the accumulated problems of the dairy industry in China.

Dairy food safety problems also occurred in developed countries. The melamine-contaminated milk scandal in China was similar to the 'swill milk' scandal in New York in 1858 (Wilson 2008). Swill milk was a filthy, bluish substance from cows tied up in crowded stables adjoining city distilleries. These cows were fed hot alcoholic mash left over from making whiskey, with added plaster of Paris to eliminate the blueness, starch and eggs to thicken the milk, and molasses to give it the yellow hue of genuine Orange County milk. The swill milk left up to 8000 children dead in a year (Wilson 2008). However, the swill milk scandal was little reported, and no related research papers were published on its impact and causes at that time. The Belgium dioxin crisis began in January 1999 (Buzby and Chandran 2003) and quickly spread across national boundaries, affecting Germany, the Netherlands and the United Kingdom. In Japan, tainted milk produced at a Snow Brand factory in Osaka affected more than 13,000 people in 2000, becoming the country's biggest food poisoning scandal in 30 years (Watts 2000). Even though absolute safety is an unobtainable outcome (Swinbank 1993), it is necessary to analyse the impacts and causes of the crises to avoid the recurrence of dairy food safety incidents.

China's dairy industry has been the subject of studies both overseas and within China since 1998. Most research addresses either the supply or the demand for dairy products in China (Zhou et al. 2002; Dong 2006; Fuller et al. 2007; Ma et al. 2007; Pingali 2007; Rae 2008; Wang et al. 2008), especially the consumption of dairy products (Fuller et al. 2003; Ma and Rae 2004; Beghin 2006; Pingali 2007; Bai et al. 2008; Rae 2008). Some Chinese researchers also studied various specific milk-related issues, most focused on policy research on China's dairy industry development (Cheng et al. 2001; Huang et al. 2008). Most previous research concentrated on the phenomenon of the fast growth of China's dairy industry. But this growth slowed after the price of corn and other supplies increased in 2005 (Han and Guo 2007; Qian and Guo 2007). The outbreak of the melamine-contaminated milk scandal put the industry in peril, but has received little attention from research community (Li et al. 2008a; Yang and Hu 2008; Ni and Zeng 2009).

In this paper, we first analyse the impacts of China's dairy crisis on enterprises, dairy farmers, consumers and the government and then explore the causes of the crisis. Even though many factors come into play when one tries to identify a food safety crisis (Buzby and Chandran 2003), we attempt to determine fundamental causes. We also discuss the reactions of the Chinese government to the crisis, including measures developed for the prevention of future food safety problems. Finally, we draw several policy implications based on our analysis and highlight the lessons learned from this crisis, which should help in the development of sustainable dairy production (Figure 1).

China's dairy crisis and its impacts

A number of kidney stone cases among infants were reported in Gansu and other provinces in China in June 2008. Investigations revealed that most of these babies had been consuming Sanlu baby formula. On 11 September 2008, the Chinese Ministry of Health announced that Sanlu milk powder was suspected to be contaminated with melamine. The Sanlu Group confessed that some of its baby formula may have been contaminated. Subsequently, the General Administration of Quality Supervision,

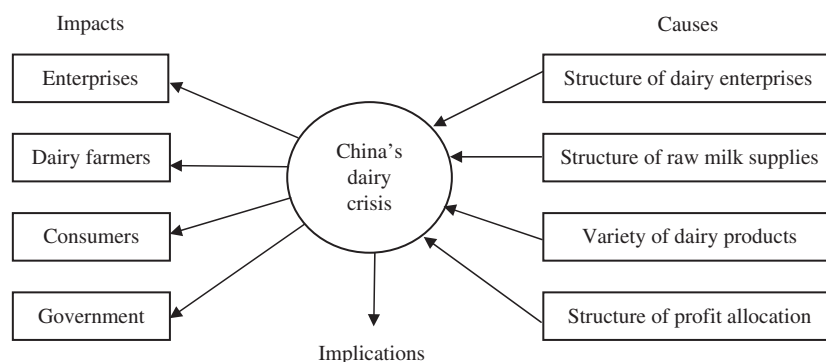


Figure 1. Analytical framework of China's dairy crisis.

Inspection and Quarantine of China (GAQSIQ) randomly inspected baby formula manufactured by another 175 firms. The results showed that 69 batches of milk powder from 22 firms contained melamine. The four largest dairy manufacturers in China – the Yili Group and the Mengniu Group of Inner Mongolia, the Shijiazhuang Sanlu Group and the Guangming Group – were also involved in this scandal. Melamine was also later found in liquid milk produced by these companies, as well as the Beijing Sanyuan Group. Milk adulterated with melamine was deemed to be a ‘latent rule’ in the Chinese dairy industry before the scandal was uncovered.

Baby formula containing melamine is a serious food safety problem that has shaken the Chinese dairy industry. In the aftermath, the industry entered a period of stagnation. Consumers lost their trust, and sales of a large number of dairy products dropped, forcing many companies to suspend production. Dairy farmers across the country dumped vast quantities of raw milk, and some even slaughtered their cows. As a result, enthusiasm for production was damaged. Even worse, the prestige of national brands was badly compromised; some countries (or regions) banned imported Chinese dairy products.

Impacts on enterprises

Enterprises are impacted by a loss of consumer confidence in their products, recalls and destruction of contaminated products, lawsuit expenses and increases of insurance premiums and costs related to equipment replacement or cleaning (Sockett 1993). A supplier’s fault is inevitably reported in the mass media, casting doubt on that company’s reputation. This affects not only the sales of that particular product, but also the sales of many other products supplied by the company’s warehouse or retailers (Holmes 1986). China’s dairy crisis impacted dairy enterprises mainly in two ways. On the one hand, the stock price collapsed and expenses associated with clearing inventories according to the national mandate created market unrest; this led to significant losses of property and wealth. On the other hand, prices increased due to government action in regulating the dairy market.

Since the Sanlu tainted milk scandal was uncovered, the State Council immediately launched a national food safety campaign. The Council mandated that the Sanlu milk powder must be recalled from the market, stores should accept all returned products and all factories of Sanlu Group must suspend production. On 12 February 2009, the Sanlu Group went bankrupt. The brand valued at CNY 14.9 billion vanished in a moment and was sold for CNY 7.3 million in May 2009.

Inner Mongolia, a major player in the dairy market in China, has suffered great losses. There are three aspects of direct economic losses from dairy enterprises. First, large expenses were incurred due to recalls of unqualified products. According to the statistics from the Inner Mongolia Autonomous Region, the total volume of lost sales in 26 cities across China reached CNY 6.4 billion

for the Yili and Mengniu Groups as of 19 September 2008. Second, losses were incurred from a drop in orders and production below capacity. Orders for the two groups fell by over 80%, and daily average milk purchase volume was only 37.62 million tons or 18.5% of the normal volume as of 22 September 2008. The disarray in production plans of enterprises certainly caused production costs to increase, revenue to decrease and sales to decrease (the decline reached more than 90% during this period). Additionally, foreign markets became largely inaccessible to these companies. Export of China’s dairy products dropped by 10.4% per year, falling to just 121,000 tons in the wake of the tainted baby milk powder scandal in 2008 (Fang 2009). Third, losses were incurred from plummeting stock prices. After the announcement of the GAQSIQ was made, stock prices for Mengniu and Yili Groups declined dramatically. The Yili stock price kept falling on 17, 18 and 23 September 2008, dropped by 9.06% on 25 September, and within a few trading days the Yili stock price went down by more than 37%. The total market value shrank by over CNY 4 billion. Mengniu stock price plunged sharply on 24 September 2008 to 60.25% on the Hong Kong Stock Exchange on the first day when it was reopened. Compared to the total market value before the close of the Exchange, Mengniu lost 18.8 billion HK dollars (US\$2.36 billion).

In addition to direct losses in dairy enterprises, the crisis caused an increase in costs. The rise in cost happened because of the accrued accounting expenses due to large quantities of returned products and unsold inventories; expenses related to mitigation measures and market public relations; expenses due to the reduced demand for dairy products; and costs incurred by stricter quality supervision regulations. The drop in stock prices and the increase in production costs left dairy enterprises in an extremely difficult situation. Although the growth rate of liquid milk sales and other dairy product output has increased by 6% in November 2008 compared with the same period in the year before, it did not help much in regaining consumer confidence and restoring the market.

Impacts on dairy farmers

The Sanlu tainted milk scandal affected not only big enterprises but also dairy farmers, the weakest link in the dairy industry chain. Many farmers suffered massive losses because of the scandal. According to statistics from the Chinese Ministry of Agriculture, the milk dumped by dairy farmers across the country amounted to 137,000 tons in the period from 21 September to 18 November 2008, and the price of milk dropped by 0.20 CNY/kg. Dairy farmers would lose CNY 16 million if 80,000 tons of raw milk were produced in a day. Cattle feed reductions would also lead to a decrease of milk production throughout the lactation period (Li et al. 2008a).

Besides the above losses, farmers suffered cost increases due to feed costs. Another problem is a milk cow shortage caused by mass sales or slaughter during the crisis. The dairy-farming industry is a long-term

industry, and the sharp decline in milk cows will have negative impacts, which will take long time to overcome. Unlike big enterprises, prices received by dairy farmers for raw milk, rank evaluation and quality appraisal are decided by the milk processing companies. Dairy farmers have neither the power to price nor the power to evaluate milk grades. Thus, they cannot defend their interests in such transactions. Although their claims for rights and benefits are rarely heard, dairy farmers are very concerned about future milk prices.

Impacts on consumers

People have lost their trust in baby formula and all other dairy products since melamine was detected in liquid milk produced by Sanlu, Mengniu, Yili, Guangming, as well as 22 other well-known manufacturers. Few enterprises were unaffected by the scandal, and mistrust quickly spread across the country. It was estimated that 40–60% of consumers either ceased or were unwilling to purchase domestic milk products, whereas those who purchased imported milk powder increased from 34% to 47%. In 5 weeks following the baby formula scandal, 86.8% of consumers switched to imported baby formula, and only 13.2% chose to buy domestic products. At the same time, sales of adult milk powder, liquid milk and ice cream were 41%, 64% and 21% of sales before the scandal, respectively (Nie 2008). A survey conducted by Lanzhou Investigation Team, National Bureau of Statistics of China, showed that 75.5% of participants declared that the Sanlu tainted milk scandal had influenced their consumption of dairy products, and only 24.4% indicated no change in milk consumption (Lanzhou Daily 2008).

Not only did the scandal affect consumer attitudes towards domestic milk powder, but foreign markets were also affected by China's dairy food safety problems. In 2008, many Asian and African countries (or regions), such as Bangladesh, Brunei, Japan, Indonesia, Malaysia, Burma, Singapore, Vietnam, Philippines, Tanzania and Taiwan, banned the import of Chinese dairy products, either selectively or entirely. The European Union also prohibited all baby and infant formula from China. Even worse, the US Food and Drug Administration declared Chinese baby formula to be illegal and urged Americans not to purchase these products in the United States.

Impacts on the government

This dairy crisis exposed some fundamental problems in China's dairy products quality control and supervision system. First, there were serious flaws in dairy quality supervision. The standard system of monitoring and control proved to be inadequate. In fact, the entire production process had numerous flaws in quality control. Second, the flawed supervision at milk collecting stations and ineffective efforts to combat illegal activities created disorder in management. Third, weak legislature, unreasonable and

outdated industry management all cast serious doubts on the government's ability to control the situation.

To avoid the enterprises undergoing repeated examinations and to reduce their burden, China began exempting those companies producing top-quality and globally competitive products from quality inspections in 2000. Some dairy enterprises had been given national inspection exemptions before the tainted milk scandal, and some of these took advantage of the exemptions to fabricate poor quality products; they used immoral methods, such as addition of chemical compounds to increase the protein in milk.

The impact of the melamine-tainted milk scandal caused a nationwide, and even global, panic over Chinese-made milk products and even affected the world image and reputation of *Made in China*, but after the Olympic Games of 2008, China's credibility increased.

Causes of the dairy crisis

The Chinese dairy industry has a short history of less than 10 years, in comparison to the decades of development in Western countries. Here, we analyse the root causes of China's dairy crisis from four aspects: structure of dairy enterprises, structure of raw milk supplies, variety of dairy products and structure of profit allocation (Figure 1).

Structure of dairy enterprises

The number of dairy enterprises increased from 500 in 1982 to 2000 in 2006 (Tan et al. 2007). According to statistics from the National Development and Reform Commission of China, CNY 10 billion were invested in the dairy industry in 2007, of which CNY 9.1 billion were used to develop new projects. Rapid construction of small and medium enterprises can easily lead to overproduction. There were 736 dairy enterprises with annual sales revenue of more than CNY 5 million in 2007. However only 12 enterprises, or 1.6% of the total dairy enterprises, are large scale. Their profits were 31.3% and their assets 28.6% of the whole industry. The medium-sized enterprises consisted of 126 companies that constituted 17.1% of the whole industry. Their combined profit was 32.5%, sales revenue was 42.9% and assets were 45.9% of the whole dairy industry. Small enterprises were the largest group, making up 81.3% (598 companies) of all dairy enterprises; 25% of which were unprofitable (Table 1). According to the statistics, the profit margin was about 48.89% for large enterprises and 7.97% for small ones. Some small enterprises entrusted large factories to produce for them. Alternatively, small enterprises often bought products directly from large companies and repackaged them for final sale. It is therefore difficult to trace product movements, making their supervision daunting.

For the efficient functioning for the dairy industry in China and to meet the diversity of markets, enterprises of different sizes are required. To meet the diversity of demand, China is destined to support not only large and

Table 1. The basic conditions of different-size dairy enterprises in China in 2000–2007.

	2000	2001	2002	2003	2004	2005	2006	2007
Total dairy enterprises	377	434	499	584	636	698	717	736
Deficit enterprises	98	110	121	158	197	196	176	166
Gross sales	193	271	347	498	625	861	1041	1309
Total assets	185	245	330	451	533	644	719	962
Large enterprises	33	33	36	9	8	10	9	12
Deficit enterprises	9	9	12	1	1	0	0	0
Gross sales	72	97	121	188	216	302	338	409
Total assets	67	91	122	143	159	205	225	275
Medium enterprises	39	46	46	88	85	109	107	126
Deficit enterprises	6	10	8	20	24	18	18	15
Gross sales	41	73	91	183	212	342	415	561
Total assets	38	66	84	166	171	243	267	442
Small enterprises	305	355	417	487	543	579	601	598
Deficit enterprises	83	91	101	139	172	178	158	151
Gross sales	79	100	134	126	195	216	286	338
Total assets	80	87	123	141	201	194	226	245
Profits of the dairy industry (%)	4.3	6.3	6.8	6.1	5.4	5.0	5.3	2–4

Note: The number of enterprises refers to enterprises with annual sales revenue of more than CNY 5 million.
Source: Dairy Association of China (2008).

globally competitive industrial groups but also big domestic enterprises and smaller regional companies, including mini-enterprises. Higher viability of some small enterprises was evidenced during the scandal. It is essential to prevent the Chinese dairy market from becoming a monopoly of big enterprises.

Structure of raw milk supplies

Chinese dairy enterprises had three main sources of raw milk supply before the scandal: (1) raw milk provided by enterprise-owned farms accounted for 10–15% of total raw milk; (2) additional milk from dairy plots and milk collecting stations, accounting for about 25%, where quality can be influenced by educational level of workers; and (3) raw milk from individual farms accounted for more than 60% of total raw milk supply, and being the main suppliers of raw milk. Milk collection often takes place at milk stations; a highly distributed scheme might be a fundamental reason for the numerous dairy food safety incidents.

Milk collecting stations are the link between individual farmers and dairy enterprises and play an important role in the dairy supply chain. The diversity of milk stations can be grouped into six types (Wei 2008): (1) milk stations run by dairy enterprises; (2) those managed by large-scale dairy farms; (3) those managed by dairy plots; (4) privately owned stations; (5) mobile milk stations; and (6) others. According to statistics from the Ministry of Agriculture, there are 20,393 milk stations across the country (Table 2). Milk collecting stations operated privately and mobile stations together constitute 63%. Without efficient control from the government these stations could easily use prohibited measures to increase their profit. Milk collecting stations serve 1.185 million dairy farmers in China, but only 5151 stations, or 25.3% of the total, have industrial and commercial business licenses, 2850 stations, or 14.0%,

have a hygiene license and about half of all stations (10,396 stations) use milking machines.

In recent years, the focus of most domestic dairy enterprises was the market rather than farm management. The statistics show that only a small number of milk stations were run by dairy enterprises, whereas most were managed by individuals, the majority of whom did not have licenses. Consequently, it is difficult to control milk quality, especially when the supply chain of a big enterprise is widely distributed across the country. The milk provided by enterprise-owned farms is not sufficient to meet demand, and as a result some companies purchase raw milk from other sources. The quality of such purchased milk is unreliable and may be one of the major reasons for the melamine scandal.

Variety of dairy products

The variety of dairy products in China is limited. Almost 80% of raw milk is used as liquid milk and for milk powder, with few high value-added products. Pasteurised milk comprised 59.9% of dairy products in 1999, and ultra-high temperature (UHT)-treated milk was only 21.1%. In 2003, UHT milk rose to 59.1%, more than half of the liquid milk market, while pasteurised milk decreased to 23.5%. The total production of liquid milk in China was 12.4 million tons in 2006 (Ke 2008). Among dried dairy products, milk powder constituted 80% of total production. Cream was produced in very limited quantities, and almost no cheese was produced in China. Whey powder, the main ingredient of milk powder, is all imported from other countries.

Pasteurised milk can be preserved for 3 days to 1 week at low temperatures. As such it is not suitable for long-distance and trans-provincial transportation. UHT milk is sterilised at high temperature so it can be preserved for 1 month or more. The melamine event mainly influenced

Table 2. Types of milk collecting station in China.

	Dairy enterprises	Large-scale dairy farms	Dairy plots	Private	Mobile milk stations	Other	Total
Quantity	2036	2395	2758	7850	4991	363	20,393
Proportion (%)	10.0	11.7	13.5	38.5	24.5	1.8	100

Source: Wei (2008).

infant formula and UHT milk; no melamine was detected in pasteurised milk. The quality of raw milk used in UHT production at high temperature is less strictly controlled compared with that for pasteurised milk. So some people adulterated raw milk to achieve higher profits.

Structure of profit allocation

China's dairy supply chain consists of four components: consumers, dealers, producers (i.e. dairy product processing industries) and providers. There are two kinds of providers: those supplying raw milk and those specialising in packaging, including the provision of machinery and materials. According to a survey of the dairy supply chain in Heilongjiang Province (Li et al. 2008b), cost and profits of the four links in the dairy supply chain, that is cow breeding, milk collection, product processing and retailing, are unbalanced. Milk collectors enjoy the highest profit, while processing enterprises are in a less advantageous position (Table 3). Individual dairy farmers get the lowest profit compared with dairy plots and modern ranches. The dairy farmers have to invest much more money and are prone to higher risk but make less profit. This so-called 'inverted pyramid' is a sign of the instability of the whole production chain in this industry (Lin and Long 2008). The dairy enterprises have the lowest cost-profit rate, which shows that unfair competition exists among the dairy enterprises. In order to get higher profits, Chinese dairy enterprises do not choose to raise milk cows: they buy raw milk from external sources, which makes it difficult to control the milk quality. The competition for resources

Table 3. Cost and profit for different actors of the liquid milk value chain in Heilongjiang Province, China.

	Cost	Revenue	Profit	Profit margin (%)
Cow breeding (average)	2.34	2.80	0.46	19.66
Individual farmers	2.35	2.51	0.16	6.81
Dairy plot	2.55	2.80	0.25	9.80
Modern ranch	2.14	3.00	0.86	40.19
Milk collectors	0.09	0.17	0.08	88.89
Enterprises	4.88	4.98	0.10	2.05
Supermarkets	5.03	5.72	0.69	13.72

Notes: The average cost and revenue of three types of cow breeding was obtained from the weighted mean value of milk output per cow per day. The milk output for cows fed by individual farmers is 11.72 kg/day; dairy plots, 15.38 kg/day; modern ranch, 17.5 kg/day. Unit: Yuan/kg. Source: Li et al. (2008b). Data for profit margins were calculated from Li et al. (2008b).

is very high when the overall supply of raw milk is not sufficient, which probably was a major contributor to the melamine-contaminated milk scandal.

Discussion

China's dairy crisis illustrates that food safety crises can have serious adverse impacts on the industry itself and on other aspects of society. Besides the costs involved in milk incidents, the dairy crisis did much harm to the image of the industry and, more generally, consumer confidence in civic governance and food policy (Frewer and Salter 2002). Dairy farmers are also the victims of the crisis, from which they have suffered despite a subsidy from the government. However, the dairy crisis prompted the Chinese government to mandate regular inspections of all food companies without exception, set new allowable tolerances for melamine in dairy products and bring in a new food safety law.

China took multiple actions to minimise the spread of the contamination, resolve the problem and be better prepared for similar crises. The government mandated Sanlu milk powder product recalled, and that all factories of this group be closed for inspection. The mandate also stated that affected babies should be examined and treated free in hospitals. At the same time, all national quality control organisations inspected sample products from all dairy manufacturers and made the results publicly available. Besides, more stringent legislation regarding milking station operations and milk storage, better supervision and surveillance of operations was developed and included in regulations and laws. Milk collecting stations now need approval to operate from local authorities. They are required to be run by dairy food producers, dairy farms or farmer cooperatives; other organisations and individuals are banned from collecting raw milk.

China's top legislature approved the Food Safety Law on 28 February 2009, which came into effect on 1 June 2009. The law will enhance monitoring and supervision, toughen safety standards, recall substandard products and severely punish offenders (Yuan and Wu 2009). The State Council, China's Cabinet, will set up a food safety commission to strengthen the country's food monitoring system, involving at least five departments having different responsibilities. The Ministry of Industry and Information Technology completed a regulation governing the manufacturing of melamine, aiming to avoid abuse of melamine in food. Manufacturers will need to apply for licenses from

the ministry, and the government will strengthen inspection of this chemical at every step, from manufacturing to sale.

The measures adopted by the Chinese government to improve food safety have clearly had positive results, although not all problems will disappear. However, the reforms will bring such problems under control and minimise adverse consequences so that the country can proceed with its efforts to become a modern, developed nation (Myint 2000). To be effective, measures to prevent dairy crises must address the underlying causes and not just treat the symptoms. Emphasis must be placed on preventing similar crises by tackling the root causes through undertaking a series of measurements. To help resolve the problems associated with the current dairy crisis in China, we suggest that the following should be considered in policymaking and operation of the dairy industry:

- (1) The configuration of dairy enterprises should be adjusted. The leading enterprises should be scaled up to strengthen their competitive capability, especially in international competition. Moderate-scale dairy farms should be encouraged, as resource use efficiency tends to be higher in smaller and mixed than in large and specialised farms (Schiere et al. 2007). Therefore, commercial, ecological and social benefits will be gained by also supporting the informal sector that provides milk in a potentially efficient way, eventually leading to a better process quality in terms of balanced development and better resource use (Schiere et al. 2007).
- (2) The dairy enterprises should optimise their products. The government should encourage dairy enterprises to innovate new, high value-added products, which would differentiate dairy products among enterprises. The imperfect market with unfair competition should be regulated to guarantee a good situation for dairy enterprises.
- (3) Most raw milk still comes from mixed and smaller farms via informal markets, but most official attention seems to go to larger specialised systems. The large range of production systems also implies variation in collection and processing 'modes' to guarantee hygienically milked and properly preserved raw milk.
- (4) Adequate safety and quality practices and controls throughout the milk supply chain, from farm to table, are important for food safety in the dairy industry (Piddock 1998; Payne et al. 1999; Khan et al. 2000). Dairy enterprises and farmers are commensal and can supplement, condition and accelerate each other. A combination of leading enterprises and small farms is the best way to sustain smallholder dairy production and marketing in China. Certain rules must be followed in all processing and distribution steps along the supply chain for food safety assurance (Demirbas

et al. 2008). Farmers, dealers and the processing industry as a whole should endeavour to ensure food quality throughout the supply chain. In addition, an effective organisational structure must be established to monitor food safety and related practices (Demirbas et al. 2008).

Beyond the provision of a legal framework within which law and order can be maintained and contracts enforced by the government, the market structure and timely institutional adjustments are also critically important. At the same time, the food industry must be held responsible for ensuring a safe supply of food to the consumer. To ensure its long-term healthy development, China's dairy industry needs to be integrated into regional and national sustainable development plans. Specific strategies and implementation schemes for such integration are important research topics for the future.

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