MSc Thesis Management Studies

Improving food safety within China's dairy chain: main issues of compliance with quality and safety standards of EU

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Abstract

Nowadays, China is faced with demands from both home and abroad to improve food quality and safety in the dairy sector. This study aims to gain an insight in the validation of quality assurance (QA) activities so as to evaluate the extent to which China's dairy industry is able to comply with EU standards along the whole dairy chain. A combination of quantitative (survey) and qualitative (in-depth interview) methods was used. The study first reviewed QA concepts, standards, and implementations of QA to formulate an evaluation framework. Based on this framework 31 indicators have been developed in a questionnaire. Altogether 33 respondents from universities/institutes, government, associations, and dairy companies completed the questionnaire by giving scores, lower scored indicators revealed the challenges to the compliance of EU requirements. 6 in-depth interviews performed with responsible experts in modern dairy industry elaborated the causes of challenges and the corresponding strategies. Some differences were found when comparing the results of the qualitative and quantitative studies.

The results revealed that 60 percent of assessed QA activities from the questionnaire were performed in advanced level and the other 40 percent of assessed QA activities were performed in higher than moderate level. It is noted that the target dairy industry in this results only refers to highly modern dairy industry in China. All other strategies and recommendations concerning the upgrade of food quality and safety activities along China's dairy chain were presented and discussed. The findings can be used as a guide for reorganizing current food safety programs aimed to improve quality and safety of China's dairy chain.

(**Keywards:** food safety, quality assurance, dairy chain)

Abbreviation key: QA = quality assurance, **HACCP** = hazard analysis critical control points, **BRC** = British Retail Consortium, **UHT** = ultra-high temperature, **CCPs** = critical control points, **MRLs** = maximum residue levels, **MOA** = Ministry of Agriculture, **VHP** = veterinary health plan.

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Management Summary

China is the third largest producer of milk in the world following India and the USA. However, the import in the EU of milk products from China has been prohibited under EU legislation since 2002. Only the composite products which contain processed milk powder as ingredients have reached EU in the past, including confectionary products, biscuits, chocolate, toffee or cakes. Furthermore, the major impact of the melamine scandal shocked the world in 2008. The European Commission extended the ban to all Chinese composite products containing milk or milk products. After this crisis, China's dairy industry is already on the way to recover.

In order to investigate the challenges faced during the compliance with food quality and safety standards of the EU, it is necessary to offer an overview on the present situation of Chinese dairy sector. The objective of this research is:

> To evaluate the extent to which Chinese dairy products are able to comply with stringent standards of EU for food quality and safety concerning the whole dairy chain. The key challenges to upgrade quality and safety of China's dairy chain will be analyzed and recommendations will be developed to facilitate China-EU dairy trade.

The Chinese quality control system appears to be more reliant on end-product inspection which applies to products rather than processes compared with the quality assurance (QA) systems in the EU. To obtain theoretical setting, theories on QA concepts, public and private QA standards (HACCP, GlobalGAP, and BRC), and the implementation of QA systems are reviewed, from which the evaluation framework with food quality and safety indicators are derived. Based on the evaluation framework, the essential indicators are selected to formulate a questionnaire.

A combination of quantitative (survey) and qualitative (in-depth interview) methods are used in this study so that topics could be discussed extensively and in greater depth. 34 respondents participated in this investigation and gave insight in the validation of food quality and safety activities along China's dairy supply chain. The empirical research is performed by conducting 6 face to face interviews and 33 questionnaires. It is noted that this research only refer to the highly modern dairy industry in China.

As a result of this research, 60 percent of assessed QA activities from the questionnaire were performed in advanced level and the other 40 percent of assessed QA activities were performed in higher than moderate level in China's highly modern dairy sector. Lower scores for assurance activities as "Traceability", "Training", "Supervision and support schemes", "Corrective actions", "Documentation & record", "Identification system", "Animal health", "Worker hygiene", "Parlor condition", "Milking/cooling equipment hygiene", "Milking/cooling equipment hygiene", "Quality control prior to/during transportation", "Cleaning procedure", "Expiration date", indicate a possible source of challenges of food

safety problems that China's dairy industry do not yet tailor these activities well.

With regards to the challenges, China is able to upgrade the quality and safety of dairy supply chain by taking into account the following recommendations:

- Dairy enterprises
  - Improve traceability of raw milk and other materials from suppliers.
  - Engage employee involvement.
  - Replace written records with electronic records.
  - Formulate private standards on higher quality of raw milk.
- Supermarkets
  - Improve traceability of milk powder products from processors.
- Governments
  - Clear-cut responsibilities of different government departments.
  - Develop and encourage structured Veterinary Health Plan.
  - Strengthen supervision on QA activities of milk collection stations.
- Milk collection stations
  - Set rules on QA activities with a system of rewards and punishments.

However, there still have challenges of food safety problems that cannot be upgraded in the near future by China's dairy industry, but the developed recommendations can be seen as a trend of development:

- Dairy enterprises
  - Integrate traceability in the complete dairy chain.
- Governments
  - Lay down new national dairy processing standards.
  - Upgrade pesticide residue standards.
- Dairy chain integration
  - Abolish milk collection station, farmers and drivers invest their dairy cows and trucks and become a shareholder of dairy processors.
  - Develop local cooperative with dairy processing line supported by government policies.

Further investigation of China's dairy industry regarding food quality and safety is possible and recommended, specially taking into account the limitations of the present research.

1. Introduction

The rapid growth of China's dairy industry over the last decades makes China the third largest milk producer in the world. However, the poorly regulated food quality and safety controls in China had led to the egregious melamine scandal in 2008. Due to growing consumers' awareness of food safety problems, it is of great importance to put in place Quality Assurance (QA) standards and guidelines to control and assure quality and safety of dairy products produced in China.

This research aims to contribute to the upgrade of China's dairy chain by offering an overview of Chinese dairy sector in accordance with quality assurance systems (HACCP, GlobalGAP, and BRC) within the European Union. EU standards are taken as benchmarks, against which the weak points along China's dairy chain can be highlighted and upgraded.

The research is structured as follows. Chapter 1 deals with problem statement, background information, project definition, research questions, research framework and research strategy. Chapter 2 describes theories on benchmarking, dairy chains, China-EU dairy trade, QA concepts, public and private QA standards, the adoption of QA standards, and the evaluation framework that provides indicators for investigating the status quo of China's dairy sector. Chapter 3 explains the use of survey and in-depth interviews to address the main issues of compliance with QA systems. Chapter 4 goes into results that elaborate the findings of the empirical research. Chapter 5 describes conclusions and discussion of the study. Chapter 6 gives recommendations for the upgrade of China's dairy chain.

1.1 Problem statement

The melamine crisis exposed the food safety problems in China's dairy chain. The most serious issue was that there were no on-site inspections as part of official controls, the control systems focus mainly on end-product testing rather than on prevention at each step of the supply chain. According to the UN (2008), "the enforcement in China of food control places an excessive reliance on end-product testing with very little use of auditing as an inspection tool". Generally speaking, The Chinese system appears to be more reliant on quality control principles which apply to products rather than processes compared with the quality assurance systems in EU (Pei, et al., 2011).

In order to investigate the challenges faced during the compliance with food quality and safety standards it is necessary to offer an overview on the present situation of the Chinese dairy sector and the extent to which Chinese dairy products are able to comply with those EU standards within the whole dairy chain.

1.2 Background information

Section 1.2.1, “the large melamine scandal in China” looks at the huge impact and existing problems of this crisis, whilst section 1.2.2, “developments of quality assurance systems” describes how the quality assurance systems facilitate the achievement of quality management.

1.2.1 The large melamine scandal in China

In September 2008, China’s melamine scandal shocked the world. Nitrogen-rich melamine was illegally added to watered-down milk to increase the measured protein content to increase profits. This crisis led to the deaths of six infants and the hospitalization of 52,000. A further 250,000 children were estimated to have suffered mild kidney and urinary problems. The immediate cost to the health system was estimated at 58 million Euro (Pei, et al., 2011).

Countries like Brunei, Singapore, Malaysia, Japan and Philippines announced bans on imports of Chinese dairy products after the melamine crisis. Meanwhile, the lack of trust from Chinese domestic consumers arouses increased demand in importing dairy products from foreign countries, such as New Zealand, United States, and the EU. According to customs statistics of China, the quantity of import dairy products were 745,000 tons with value of $1.97 billion in 2010, increasing 24.9% and 91.6% respectively compared with 2009. However, only a total of 34,000 tons of dairy products worth $43.9 million were exported from China in 2010, which dropped 8.2% and 22.6% respectively from 2009 (Table 1.1).

Table 1.1	China’s import and export of dairy products in 2010			
Dairy products	**Quantity (tons)**	**Variations (%) 10/09**	**Value (million)**	**Variations (%) 10/09**
Import	745,000	+24.9	$1,970	+91.6
Export	34,000	-8.2	$43.9	-22.6
Source from customs of the People’s Republic of China				

Figure 1.1 China’s import and export of dairy products around the world

Imports of dairy products from the EU after the melamine scandal increased — Statistic shows that 42,000 tons of dairy products were imported from the EU in the first four months of 2009, which was 27.2% over the same period of last year (www.askci.com). In reverse, the EU extended the ban on milk products from China since 2002 to all Chinese composite products containing milk or milk products (European voice, 2008). China’s main dairy trade partners after the melamine crisis around the world are shown in Figure 1.1.

The melamine crisis exposed the problems of governance on China's dairy sector:

- When the melamine affair was first reported, the government did not even know which of its departments should be responsible for it (Xiu and Klein, 2010). There was no single government agency that had clearly identified responsibility for controlling the numerous private raw milk collection stations which is the crime site of melamine adulteration (Chen, 2009).

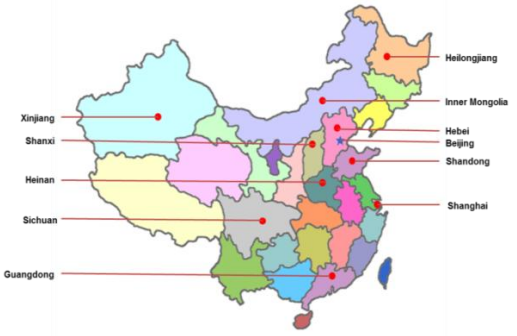


Figure 1.2 The major dairy producing areas are the regions of northern, northeastern and northwestern China by reason of their climate and grasslands. Main producing cities are Heilongjiang, Inner Mongolia, Xinjiang, Hebei, Shanxi, Shandong, Beijing, Heinan, Shanghai, Sichuan and Guangdong. The governance in such a vast country is extremely difficult.

- The governments at all levels have focused on economic growth rather than inspection and safety issues. The performance evaluation of senior government officials often is affected by the magnitude and growth rate of gross output within their jurisdictions (Xiu and Klein, 2010). This leads to the permission for major dairy processors to implement their own inspections as they were labeled "exempt of inspection" before the melamine crisis (China Food Industry, 2004, according to Xiu and Klein, 2010). The government brought a new food law in 2009 to stipulate regular inspections of all companies involved in the food business with no exemptions.

- The uneducated poor dairy farmers are not trained properly by local governments. This results in difficulties in managing their cow operations and disease control. Also, as price takers the farmers are pressurized to sell at low prices, which compelled them to reduce average costs, for example, the use of self-produced feeds. This cause adverse impact on the quality and safety of raw milk (Xiu and Klein, 2010).

All in all, the problems in China's dairy industry were a result of rapid growth fueled by concentrated processing sector that obtained its raw materials from millions of small, poor and uneducated traditional farmers. And the government supported and encouraged growth but with little emphasis on inspection and safety issues (Xiu and Klein, 2010). All the exposed problems indicate that a more responsive system of governance on China's dairy sector will be needed.

Section 1.2.2 clarifies the "quality assurance systems" that can be used to direct quality policies and achieve quality objectives.

1.2.2 Developments of quality assurance systems

The importance of food quality has long been recognized. Concerns about food quality

started with quality inspection that quality inspectors took out non-conforming products at the end of the production line. Quality products were obtained by removing defects by inspection (luning et al., 2006). Since at the end of the production chain, there is no way to correct production failures or upgrade the quality of the final product. The production costs of defect products had been as high as those of the regular quality products. The needs to produce high quality products and increase the efficiency of production process, however, has led to the development of quality assurance systems along production chains (Blaha, 1999).

Quality assurance encompasses all planned and systematic actions required to ensure that a product complies with the expected quality requirements. It also provides customers and consumers with the assurance that requirements will be met. Quality assurance focuses on system quality instead of product quality, the system must be audited to ensure that it is adequate both in design and use. So, the focus changed from how to inspect to how to produce. Food products are not only tested on their product characteristics, but also on production, packaging, handling and distribution (Luning et al., 2006).

Nowadays, consumers have become more and more critical about food quality and safety. In order to build and maintain trust of consumers, QA is of major importance in the food sector (Spiegel et al., 2003). QA programs such as good manufacturing practice (GMP), Hazard and Critical Control Points (HACCP), and BRC (British Retail Consortium) have been employed to ensure food quality and safety and to build and maintain consumer trust (Kupper and Batt, 2009). Moreover, QA systems are directly influencing market access for food producers as important indicators of competitiveness. Certain QA programs are even becoming mandatory for meeting market entry requirements, e.g., the Global Partnership for Good Agricultural Practice (GlobalGAP) in the fresh produce sector (Kupper and Batt, 2009).

1.3 Project definition

This research could be considered as a practice-oriented evaluation research.

As stated in previous section, Chinese dairy products were banned by EU legislation since 2002 because of the imperfection of residue pesticide system in China. The ineffective governance in the dairy sector, especially no on-site inspection in raw milk collection stations, caused the melamine scandal in China in 2008, which arouse a total ban including the composite products contained milk powder as an ingredient in the EU.

Quality assurance systems aim to give guarantees at each step in the food production chain to ensure safe food and to show compliance with regulatory and customer requirements. The implementation of major QA systems like HACCP, BRC, and GlobalGAP help upgrade the quality and safety of China's dairy chain so that Chinese dairy products can be produced according to the QA standards, which is a prerequisite to

make the import of dairy products from China to the EU possible.

The aim of this research is to examine to which extent the compliance with EU food quality and safety demands have come true. The cause of the gaps will be analyzed and suggestions will be made for the future.

In the formulation of research objective, the subject of the research is defined and embedded.

> The objective of the research is to evaluate the extent to which Chinese dairy products are able to comply with stringent standards of EU for food quality and safety concerning the whole dairy chain. The key challenges to upgrade quality and safety of China's dairy chain will be analyzed and recommendations will be developed to facilitate China-EU dairy trade.

1.4 Research questions

The research objective will be further realized by formulating research questions, which consists of one central question and five sub questions. The central question is derived from the objective and the sub questions are derived from the central question.

> **Central research question**
> To what extent do Chinese dairy products comply with quality and safety standards of EU and how can the quality and safety of the dairy chain be upgraded so that Chinese dairy producers will be able to produce according to these standards?

The central question will be answered in the conclusions of the research. To answer this central question the following sub questions are formulated. Sub questions provide more information on the data to be gathered so as to answer the central question.

1. Which representative dairy product is selected from a broad range of dairy products to conduct an in-depth investigation based on the past China-EU dairy trade record?

2. What is an evaluation framework with indicators to assess food quality and safety performance of entire China's dairy chain?
    a. What are the indicators extracted from quality assurance (QA) concepts?
    b. What are the indicators extracted from QA public and private standards in the EU?
    c. What are the indicators extracted from the implementation of QA standards in different regions of the world?

3. To what extent does China's dairy chain comply with extracted food quality and safety indicators?

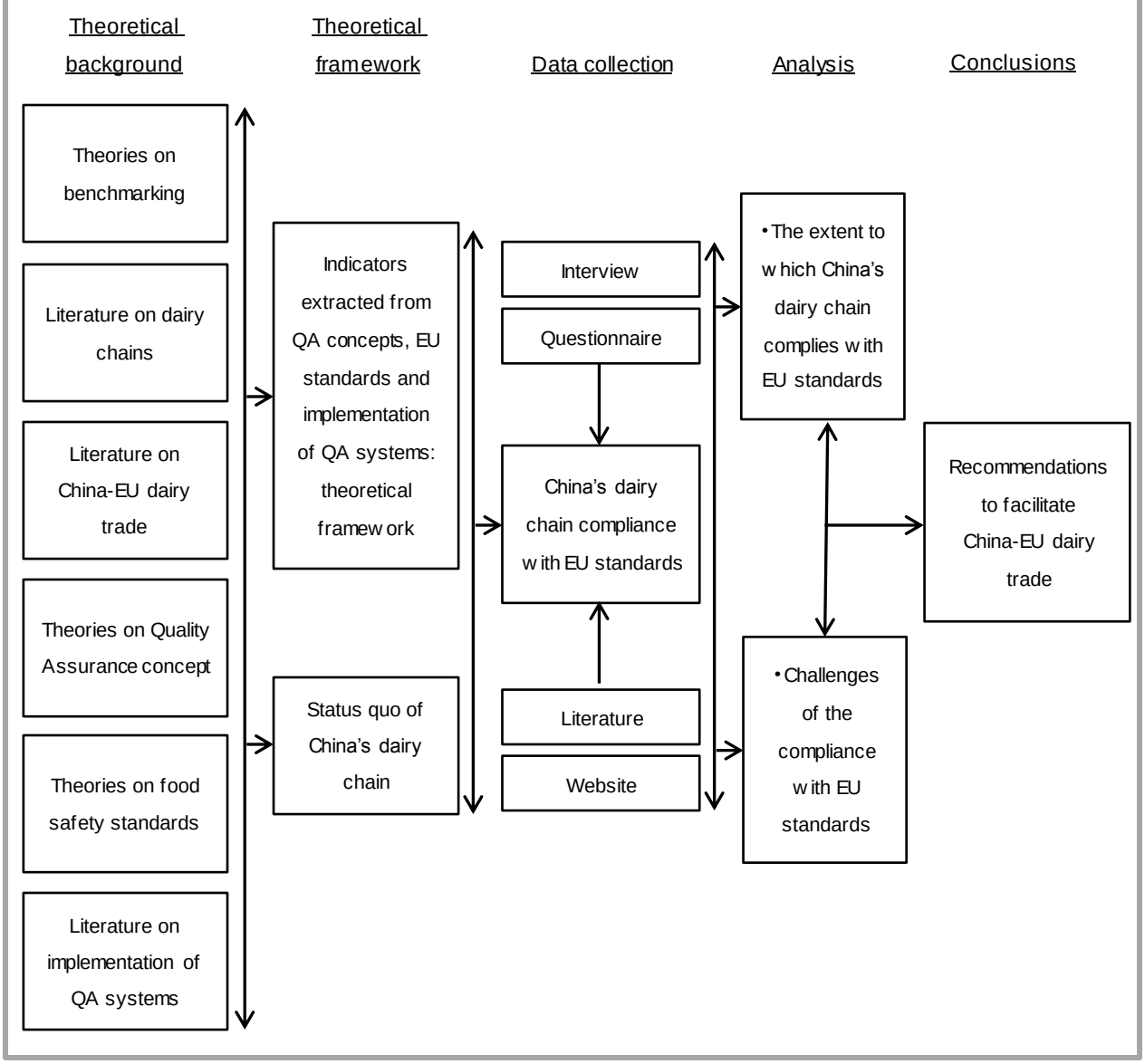
4. What are the key challenges to upgrade the quality and safety of China's dairy chain?

5. What policies or strategies are developed to improve the quality and safety of China's dairy chain?

1.5 Research framework

The research structure is developed into a research framework, which includes the steps that need to be taken in order to realize the objective. The research framework has been built and illustrated in Figure 1.3.

Fig. 1.3 **Research Framework**



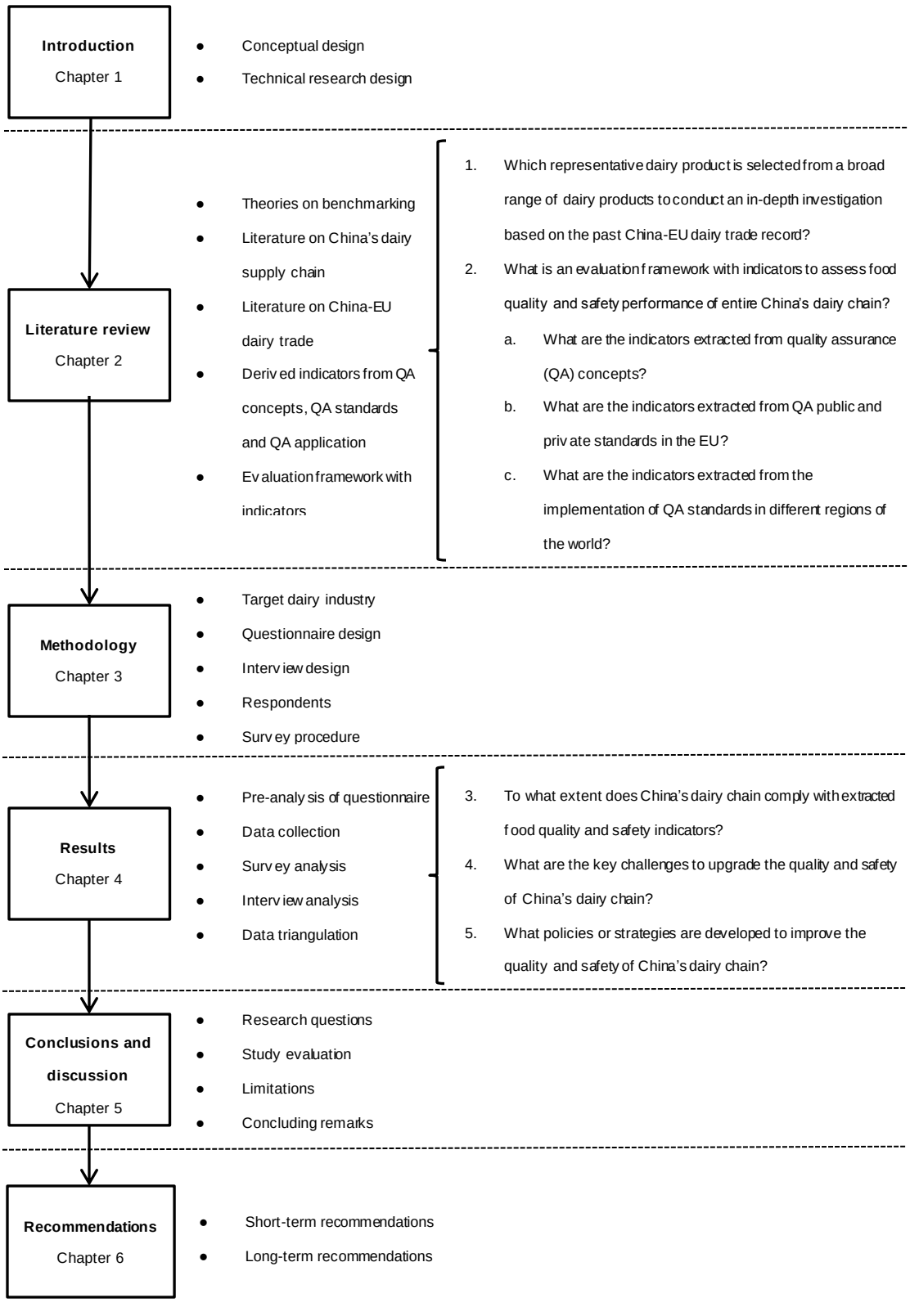
Key concepts and theoretical framework of the research are derived from the theoretical background. Concept on benchmarking provides an approach to compare indicators for food quality and safety between EU standards and China's dairy chain, allowing an evaluation of food quality and safety issues of China's dairy sector. In relation to the scope of this research, the whole dairy chain from farmer to table, it is necessary to define actors and stages of dairy chains in advance. Data on China-EU dairy trade will be used to identify the target dairy product investigated in this research. Quality assurance (QA) concepts, typical QA standards and the implementation of QA standards are used to extract the indicators to benchmark the performance of Chinese quality and safety system.

Data collection is primarily based on interviews with experts and questionnaire method. Additional information from literature and websites will be used. Respondents will be experts from certification agencies, Chinese government authorities, dairy associations; researchers from universities and institutions; and workers from dairy companies.

In the analysis and conclusion phases, the collected data will be analyzed with the key indicators from the theoretical framework. Namely, a comparison between the investigation of China's dairy chain and the QA standards of EU for food safety and quality concludes with the challenges and recommendations for facilitating China-EU dairy trade.

In order to ensure good realization of the research objective, an outline of the report that follows the planning of the research is presented in Figure 1.4.

Fig. 1.4 **Outline of the report**



1.6 Research strategy

This research could be considered as a survey which provides an overall picture of a wide area of knowledge on the status quo of Chinese dairy sector. The objective of this survey is to evaluate the degree of the food quality and safety performance in China's dairy sector using indicators which are extracted from theories on quality assurance concepts and public and private food safety standards.

The target units ($n \geq 30$) could be researchers from university and research institute, key staff members of governments and certification agency, members of dairy association, and workers in dairy company. The survey is sent to a random sample because the respondents need to have insights on the entire China's dairy chain as well as having knowledge on quality assurance standards. Also, a combination of quantitative (questionnaire) and qualitative (in-depth interviews) method will be used in this research so that the challenges and solutions to the compliance between China's dairy sector and EU demands could be discussed more completely and in greater depth.

The contact details of experts are obtained through certain channels. For example, most websites of authorities, certification agencies, and associations provide telephone numbers, and the publishers of certain food science journals may leave e-mail address of the authors, other ways like the professor/students who work/study in a university in the dairy field may introduce more experts.

The next chapter discusses benchmarking, dairy chains, China-EU dairy trade, quality assurance concepts, public and private QA standards, implementation of QA standards, and evaluation framework.

2. Literature review

In section 2.1, theories on benchmarking are presented. The benchmarking approach in this research depends upon collecting and analyzing the data from China's dairy chain underpinning the evaluation framework on which the comparisons are based. China's dairy supply chain is presented in section 2.2.

The present chapter will also answer the following research question:

Sub question 1. Which representative dairy product is selected from a broad range of dairy products to conduct an in-depth investigation based on the past China-EU dairy trade record?

The target dairy product among a broad range in this research is not chosen randomly, but the most valued one is taken into account — the product which has the best chance of reaching the EU market and covers the whole dairy chain from farm to table. To choose a target dairy product for assessing the food quality and safety performance of China's dairy chain, a literature study on China-EU dairy trade (section 2.3) has been done.

Sub question 2. What is an evaluation framework with indicators to assess food quality and safety performance of entire China's dairy chain?

a. What are the indicators extracted from quality assurance (QA) concepts?
b. What are the indicators extracted from QA public and private standards in the EU?
c. What are the indicators extracted from the implementation of QA standards in different regions of the world?

Relative to China, the European Union countries adopt more stringent QA systems with a broader scope to decrease risks for EU consumers. This necessitates China's exporting organizations to fully understand the QA requirements. Indicators (major QA requirements) that formulate an evaluation framework (section 2.7) for food quality and safety are extracted from theories on quality assurance concepts (section 2.4), typical general and private standards (section 2.5), and the implementation of QA systems in other regions of the world (section 2.6).

2.1 Theories on benchmarking

Benchmark is a standard, or point of reference, against which things can be compared, assessed, measured or judged. Benchmarking is the process of comparing performance using indicators resulting in a point of reference in an effort to identify areas of improvement (OECD, 2006; Productivity Commission, 2009). Xerox Corporation fist adopted benchmarking in the late 1970s. Since then, managers in different industries have used it to evaluate and improve the quality of their products, as well as work

processes and work procedures (Lai et al., 2011). Benchmarking as a very versatile tool helps an organization to objectively and thoroughly evaluate its processes to see if and how they can be improved relative to either its peers or against some standards (Productivity Commission, 2009; Lai et al., 2011).

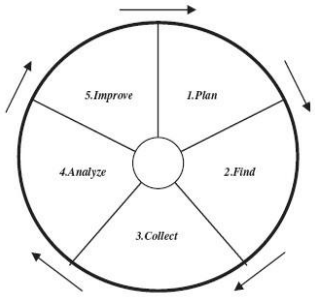


Figure 2.1 A benchmarking wheel (Lai et al., 2011). Benchmarking wheel is a benchmarking process model that synthesizes advantages of a large number of existing benchmarking models (Anderson, 1995, according to Lai et al., 2011). The benchmarking processes are described in Box 2.1.

Box 2.1 Benchmarking processes (Lai et al., 2011)

Step 1. Plan

Determine the process to benchmark based on the organization's critical success factors and measure the performance of the process.

Step 2. Find

Identify benchmarking partners.

Step 3. Collect

Understand and document the benchmarking partners' performance and practice.

Step 4. Analyze

Identify gaps in performance and the root causes of the gaps.

Step 5. Improve

Plan the implementation of improvements, implement and monitor the improvement processes.

The benchmarking model in this research is used to evaluate food quality and safety activities in China's dairy sector includes five steps: (1) conducting a preliminary analysis, which provides the stages of dairy chain to benchmark and the target dairy product; (2) identifying indicators from the main concepts of QA systems, public and private standards, and barriers to the application of QA systems based on existing research; (3) collecting data to assess food quality and safety activities in China's dairy chain; (4) analyzing the extent of validation of core activities and the causes for the gaps; (5) developing solutions and presenting results to advisor. Food quality and safety indicators can be used as a mechanism of benchmarking (Tung and Yang, 2009). A comparison of indicators between the requirements of QA systems and the status quo of China's dairy sector allows for an evaluation of validation of food quality and safety activities in China's dairy sector and offers the opportunity to identify weak points and potential improvements in China's dairy chain.

2.2 Literature on dairy chains

Xiu and Klein (2010) provided a schema (Figure 2.2) of a dairy supply chain in China with principal participants, i.e., retailers and wholesalers, milk processing companies, milk collection stations and dairy farmers. Governments, research institutes and universities, credit institutions and input supply firms also are integrally involved in the industry. The nature of these actors is discussed below according to Xiu and Klein:

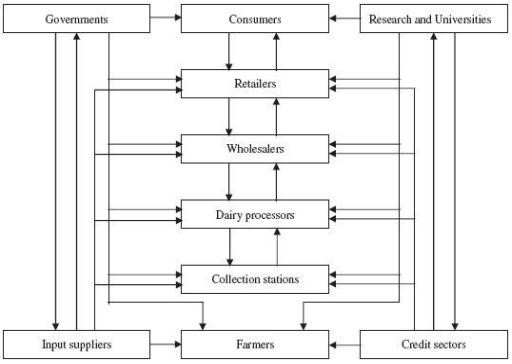


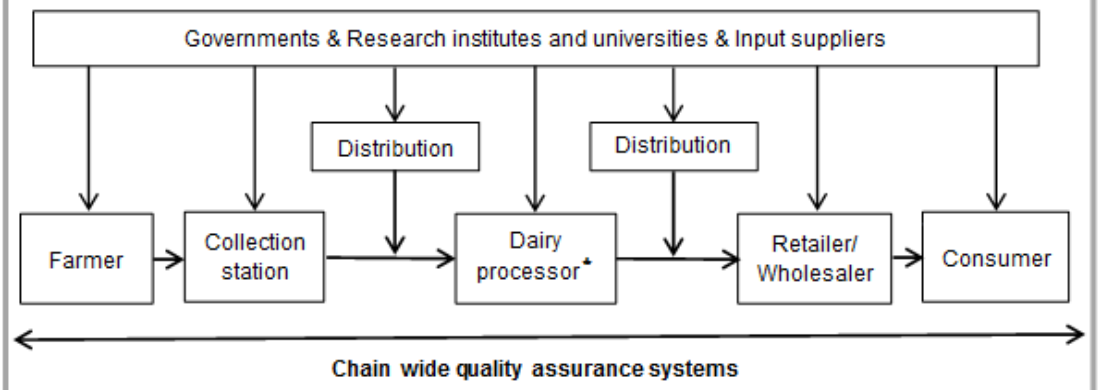
Figure 2.2 A dairy supply chain in China

- *Retailers and wholesalers*. Retailing of milk product takes different forms throughout the country. Fuller and Beghin (2004) emphasized the importance of supermarkets in dairy product marketing in the fact that more than half of urban Chinese householders that reported milk purchases in surveys indicated making purchases at a supermarket.
- *Milk processing companies*. The processing companies convert and package the raw milk into various final milk products for consumption. Most of the raw milk is from suppliers with contracts.
- *Milk collection stations*. Milk collection stations are the locations with cubicle cattle sheds where small dairy farmers move their cows to milking parlor for milking. The regular activities of a milk collection station are cleaning cows' udders, milking, milk storage and shipment. Although some milk collection stations are owned by the large dairy processors, most are separate operations that are owned by private business investors who have contracts with large processors.
- *Dairy farmers*. Almost all farmers live in small rural villages and work on large collective farms. Their lack of knowledge makes it difficult to manage dairy cow operations. They are price takers with no power to affect sales or inspections.
- *Governments, research institutes and universities, credit institutions and input supply firms*. They have played increasingly important roles by providing credit, feed, training and technical assistance to both farmers and local technicians. Many local governments have regarded the dairy industry as important industry for developing the local economy. As a result, preferential policies and strategies have been designed to promote growth of the dairy industry.

The complex and interlinked nature of food safety hazards and food production as a whole has been widely recognized. An integrated approach to control food safety throughout the entire food chain ("farm to table") has become an important issue in guaranteeing a greater food safety level for consumer products (Stefan, 1997 and Valeeva et al., 2004, according to Valeeva et al., 2005). In line with this, all the independent actors are able to affect the food safety level of the end product of the whole dairy chain. Transportation between the stages is also considered, i.e., transport of raw milk to the processing factory

and delivery of final product to the sale unit (Valeeva, et al., 2005).

Fig. 2.3 Dairy supply chain in China assuring safe food production (★ highly modern processor)



As mentioned earlier, improving food safety in China's dairy chain should focus not only on the main actors within the chain, but also on the links relating to these actors. Figure 2.3 presents the whole dairy chain in China assuring safe food production. It is important to note that the dairy processor refers to highly modern processor in this research, which is determined by the characteristics of China's dairy industry:

The number of enterprises involved in dairy processing rose from 355 in 1998 to 717 in 2007 (China Ministry of Agriculture, 2008, according to Pei et al., 2011). The majority of dairy enterprises in China are still small processors for local markets. However, the dairy industry focused in this research refers to large dairy processing companies that have modern equipment and use advanced technologies and managerial methods in their dairy operations and search for exporting opportunities (Xiu and Klein, 2010). This is because the large modern milk processing firms have the best chance to comply with EU standards and make the exportation possible.

2.3 Literature on China-EU dairy trade

Previous sections have presented the benchmarking approach and China's dairy supply chain. In this section the research sub question 1 "*Which representative dairy product is selected from a broad range of dairy products to conduct an in-depth investigation based on the past China-EU dairy trade record?"* will be answered.

The rapid growth of China's dairy industry has promoted a broad range of dairy products, including milk, cheese, yoghurt, cream, milk powder, and so on. Liquid dairy products and dried dairy products such as milk powder are two major categories made in China (Bao, 2011). Liquid dairy products include pasteurized milk, UHT (Ultra-High Temperature) milk, fermented milks, and milk beverages. Fermented milk products such as yogurt and milk beverages are becoming popular, especially with functional ingredients. The consumption of whole milk powder, which was the main type of milk powder in the past decreased to 20%

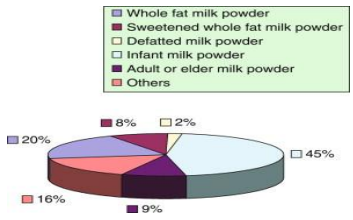


Figure 2.4 Consumption of milk powders in China in 2006

in 2006 (Figure 2.4). Infant formula has obviously higher proportion in milk powder category (Bao, 2011). However, in February 2011, a survey conducted in Beijing showed that nearly 70% of respondents from the supermarkets said they would not choose Chinese domestic infant milk powder because of the lack of trust after the melamine crisis, and the sale of imported infant formula was much better than the Chinese domestic infant formula (http://health.hsw.cn/system/2011/02/28/050808093.shtml).

In fact, the import in the EU of milk products from China has been prohibited under EU legislation since 2002, saying that the Chinese residue pesticide system did not reach standards set down by the EU (China Agricultural Newsletter, 2008). It is still a long way to satisfy the EU such that imports will be accepted again because of the unimproved residue pesticide system in China (investigated by the researcher). The number of tests and the maximum residue limit still cannot achieve EU standards within three years. Only certain amounts of composite products (i.e. products which contain a processed product of animal origin and a product of non-animal origin) containing processed milk components may have reached the EU after that year, including confectionary products, biscuits, chocolate, toffee or cakes (Coulombier et al., 2008). In 2007, the EU imported about 19,500 tons of confectionary products from China, including pastries, cake and cookies, and about 1,250 tons of chocolate and other prepared foods containing cocoa (Joshi, 2008).

On 26 September 2008, due to the impact of melamine crisis in China, the European Commission extended this ban to all Chinese composite products containing milk or milk products, primarily intended for infants and young children, which could contain traces of milk powder (European voice, 2008). The EU consumers are even warned against ordering Chinese dairy products on the Internet. The monthly bulletin on external and intra-European Union trade (NO. 12/2010) provides data showing that the imports of dairy products and bird's eggs in the EU were mainly from EU-27 and Switzerland with value of 1,066 million Euro and 575 million Euro respectively from January 2009 to August 2010, whereas no Chinese dairy products at all reached the EU market during that period.

As stated previously, among the numerous dairy products, the one has the best chance to enter EU market is the whole milk powder, which can be composite products. The reasons are as follows:

- Nutrition value. The whole milk powder retains almost the complete nutrition ingredient originally in the raw milk compared with other dried dairy products. Beyond concentrated calcium, protein and other nutrient values, several desirable properties, such as browning/color, emulsification, flavor, foaming and water binding, are achieved through the addition of whole milk powder to food formulations (DMI, 2005).

- Widespread application. Whole milk powder is widely applicable in the food industry. It can be used in bakery products, confectionary products, milk chocolates, processed meats, ready-to-cook meals, baby foods, ice-cream, yogurt, health foods and reduced-fat milks. Industrial-grade powder is used for animal fodder (www.dairyaustralia.com.au).

- Export motivation. Whole milk powder is a major category of dairy products made in China. As local producers gradually rebuild China's dairy herd from the sharp reductions after the 2008 melamine crisis, China's whole milk powder production is expected to increase five percent to over one million metric tons in 2011 compared with 0.78 million metric tons in EU-27, (Woolsey et al., 2010; Rucinski et al., 2011). However, the main consumption pattern of Chinese dairy market has changed from milk powder to liquid milk (Beijing Orient Agribusiness Consultant, 2007). Also, a large proportion of Chinese consumers still shun domestic whole milk powder after the melamine crisis. The strong production capacity and the decreased consumption demand push the export of whole milk powder (as composite products).

- Chance to lift the ban. In view of the ban under EU legislation since 2002, the import of Chinese dairy products leaves much to be desired besides safety problem. And the imports of dairy products can be generally satisfied within EU-27 countries. Nevertheless, the market of composite products still has great potential based on the past trade record. Thus, only the ban on composite products containing milk powder as ingredient has the best chance to lift. Though it is not yet formally proved, the imports of composite products are on the road to recovery on the premise of upgrading quality and safety of whole milk powder production.

- Referring entire dairy supply chain. Quality assurance activities for safe whole milk powder production refer to the whole dairy chain from farm to table. Food quality and safety activities from every stage of China's dairy chain will be analyzed during the investigation of whole milk powder producing processes.

In conclusion, based on the past China-EU dairy trade, it is clear that the whole milk powder is selected among the numerous dairy products to conduct an in-depth investigation in this research.

2.4 Theory on quality assurance concepts

"Quality assurance" is included in a preventative approach dealing with all hazards involved in the food processing steps, acting as a control of quality in each step of the process (Cruz et al., 2006). From the study of theories in this section, the research sub question 2.a *"What are the indicators extracted from quality assurance (QA) concepts?"* will be answered.

According to Luning et al., (2006), a techno-managerial approach is developed to

recognize both technological and managerial aspects that can influence the performance of QA systems with respect to assurance of food safety. It implies that the safety of the final product is a result of product characteristics and process conditions (technological) on one hand, and human behavior and working conditions (managerial) on the other hand.

2.4.1 Managerial aspects in quality assurance

Human behavior and its working environment can affect food safety. Luning et al (2006) introduced managerial aspects of changing conditions (e.g. implementing systems, improvement), decision-making, and quality behavior as elements to manage quality assurance issues. Attention is also paid to auditing and certification proposed by Luning and Marcelis (2009).

Change strategy

The implementation of QA systems is not just the introduction of a system with procedures and/or guidelines which have to be followed. It often requires a change in beliefs and values shared by people in the organization (Luning et al., 2006). Choosing an adequate change strategy is very important to implement and/or improve quality assurance processes. Luning et al (2006) summarized three common change strategies:

- Force-coercion strategy
  A force-coercion strategy uses the power bases of legitimacy, rewards and punishments as primary inducements to change. Likely outcomes are immediate compliance but little commitment. The new behavior continues only as long as the opportunity for rewards and punishments is present.
  This strategy is most useful to help people break old patterns of behavior and gain the initial motivation to try new ones.
- Rational persuasion strategy
  A rational persuasion strategy attempts to bring about change through persuasion backed by special knowledge, empirical data and rational arguments. Although slower than force-coercion, it tends to result in longer lasting and internalized change. This strategy largely depends on the availability of expert power in the form of consultants, external experts or credible demonstration projects.
- Shared power strategy
  A shared power strategy engages people in a collaborative process of identifying values, assumptions, and goals from which support for change will naturally emerge. Because it entails a high level of involvement, this strategy is quite time-consuming, but it is likely to result in a longer lasting and internalized change.
  For this change strategy, managers need reference power to work effectively with other people in group situations relies on group norms. Others are allowed to participate in making decisions that affect the planned change and the way it is implemented.

Decision-making

As decision-making plays a role at all stages in a food chain, it is important to understand which decisions can be made as a result of quality assurance activities. On a management level decisions have to be made on, for example, the extent of sampling and the number of critical control points. Management also has to decide on investment in resources such as new equipment, qualified personnel, education and training, etc. At operational level decisions are made as well, for example, composition of quality system project team, acceptance or rejection of batches, regulation of pasteurization temperature, washing hands or not (Luning et al., 2006).

Quality behavior

Quality behavior is how people act on quality and safety related issues (Luning and Marcelis, 2009). A research model on quality behavior that two factors influencing behavior with respect to quality performance are considered: disposition and ability. Disposition refers to people's behavioral intentions and awareness of the acceptable quality standards. Ability refers specifically to physical conditions and personal skills, which enable people to really meet requirements. Disposition is the outcome of processes within people's minds, while ability is the result of organizational factors (Luning and Marcelis, 2009).

Quality auditing and certification

Audits are a systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives (ISO 9000:2005). Various quality assurance standards have described detailed procedures for auditing the specific standards (Luning and Marcelis, 2009).

Three types of audits can be distinguished (Luning and Marcelis, 2009): (a) the first party audit is an internal audit and is carried out by the company for management purpose such as improvement of the internal quality system; (b) the second party audit is an external audit and is carried out to audit a potential supplier against proposed requirements when a contract is to be drafted; (c) the third party audit is an external audit and implies an independent audit organization assessing organizations against a quality system standard. It provides a certificate which records the results of the audit.

2.4.2 Technological aspects in quality assurance

Where quality management is focused on human behavior and its environment, food technology involves the typical food product and production aspects (Luning et al., 2006). It is increasingly recognized that the quality and safety of the end product depends on

quality assurance in all parts of the chain and proper transfers between each chain actor (Luning et al., 2006). Major technological factors along the food supply chain that can influence final product quality are explained by Luning and Marcelis (2009):

Primary production

The major actors in primary animal production chain are farmers and transporters, whose behaviors relate to animal breed, feeding, living conditions, animal health and transport can influence quality and safety of final product.

- Animal breed has a significant influence on quality attributes. Some breeds have genetic predispositions for typical quality parameters of animal products.
- Animal feeding affects the quality of animal products. Both the amount and the composition of feed can influence yield and/or the composition of animal products. Moreover, environmental contaminants and pathogens in feed can affect the safety of animal products.
- Housing conditions of animals refer to hygienic conditions and movement circumstances can have a considerable impact on the bacterial load of the exterior surfaces of animals.
- Animal health and the use of veterinary drugs can also influence product quality. Moreover, animal diseases can be treated with antibiotics and their residues in animal products are assumed to be hazardous for human health.
- Transportation has a significant impact on the sensory properties, safety, and microbial shelf life of products.

Processing and distribution

The food processing determines the factors of influence on quality and safety, and the distribution conditions are important in the transport of products from one actor to another.

- Factors in storage and subsequent preparation of raw material
  The initial quality of raw materials is a dominant factor influencing the quality and safety. Storage conditions like temperature, packaging and hygiene are common factors that can affect the quality of raw materials during storage.
- Factors in the transformation of raw materials and packing of final products
  Product can undergo various process steps, such as heating, drying, evaporating, extruding, fermenting, etc., the choice of technique and equipment conditions are important factors influencing the final quality. Packaging integrity, materials, and labeling can influence the shelf life and safety of final products.
- Factors in the storage and distribution of final products
  Subsequent storage and distribution conditions aim at maintaining the properties of finished products. The main factors are temperature, duration, relative humidity, and integrity of packaging materials.

Retail and final food handling

Retailers are commonly the last actor before purchase and food preparation. Critical factors that can influence final quality at this stage are storage conditions of suppliers, conditions in the shop, and hygienic handling of personal. Factors influencing quality at home, catering establishments and restaurants are related to conditions of domestic storage equipment, hygienic circumstances and cooking conditions.

2.4.3 Derived components from main QA concepts

From the literature study on QA systems, key indicators have been extracted to analyze the performance of QA systems along all stages of food supply chain. Main areas for assessment of QA activities are highlighted and corresponding indicators are proposed from the perspective of both managerial and technological aspects. The QA areas will be distinguished by the bullet ★ while the indicators will be distinguished by the bullet ☆ (Appendix 1).

2.5 Theory on food safety standards

In this section, the research sub question 2.b *"What are the indicators extracted from QA public and private standards in the EU?"* will be answered.

HACCP (Hazard analysis and critical control points) system as a generic standard and private standards like GlobalGAP (formerly known as EurepGAP) and BRC (British Retail Consortium) represent the most important quality assurance systems and the demands regarding food safety from EU retailers. All these standards are similar in the sense to specify the minimum requirements acceptable for food safety. The certification can be carried out by licensed third-party professional audit organizations and requires continued compliance with the systems. These QA standards cover part of a quality system prescribe production practices from the farm level to the retail level (Figure 2.5) including transportation and storage. The major difference amongst the standards is that they are owned by different stakeholders in different geographical regions. HACCP seek to specify generic requirements that could be adapted to chain participants at different functional nodes in value chains, GlobalGAP and BRC are specific to primary food producers and food processors respectively (Mensah and Julien, 2011).

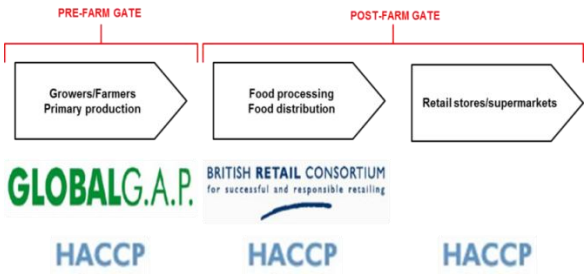


Figure 2.5 QA systems: classified based on stage of the supply chain

Distinguishing private standards from HACCP, which have been developed by public authorities or inter-governmental organizations and aim for a consistent documentation of

FSMS Elements	BRC	HACCP
Management system	✓	✓
Prerequisite programmes	✓	✓
HACCP	✓	✓
Validation & verification	✓	✓
Emergency preparedness/ crisis management	✓	
Quality management	✓	

Figure 2.6 Key common requirements for HACCP and BRC

the production process, retail standards like GlobalGAP and BRC can be understood as a joint action of retailers and require clearly defined production criteria (Herzfeld et al., 2011). HACCP principles can be seen as foundation to assure food safety, while private standards integrate more quality management system requirements for different chain participants. Mensah and Julien (2011) compared key common requirement for HACCP and BRC (HACCP based) in Figure 2.6.

2.5.1 HACCP system in the dairy sector

HACCP has long been internationally recognized and accepted as a system for effective food safety management (CAC, 2003, according to Sampers et al., 2012), which assesses hazards and establishes control systems that focus on preventive measures instead of relying primarily on end-product testing (Vilar et al., 2011).

European legislation has obliged the use of the HACCP concept for quality risk management programs throughout the whole dairy food chain, but dairy producers are not yet obliged to introduce a full HACCP program. The European Union currently advises primary producers (dairy farmers) to apply a HACCP like program on their farms (Vilar et al., 2011). The twelve steps in the application of HACCP including the seven principles adapted to the on-farm study are shown in Appendix 2. The critical control points regarding raw milk collection and milk powder production in the dairy sector in line with the HACCP principles are explained in Box 2.2.

Schothorst and Kleiss (1994) discussed the details of implementing HACCP system in the dairy industry. They highlighted the critical control point in pasteurization, which is an essential preventive measure for potential hazards in raw milk. Heating time and temperature are the parameters to accomplish this step. Cooling pasteurized milk in the next step includes necessary maintenance of the equipment because leaks in the barrier between the milk and the cooling fluid can occur and cannot always be predicted. In the meantime, a slight over-pressure on the pasteurized milk side can control the recontamination hazard. Additionally, the line environment during these steps becomes an important aspect. Tight barrier between the product and its environment as well as the hygienic practices are the measures to control the hazard of recontamination. More CCPs in the dairy production are described by Arvanitoyannis and Mavropoulos (2000), such as collection and transportation, reception of milk, filtration, etc. Furthermore, WHO (2008) emphasized the establishment of traceability system for wholesalers, central distribution centers and retail food businesses based on the HACCP system: each wholesaler, central distribution center, or retailer should at least be able to ensure that foodstuffs in their control are traceable to the supplier; and the system should be reviewed at least yearly to ensure that it is delivering the required level of traceability.

Box 2.2 HACCP and Critical Control Points in the Dairy Sector (Leitlinie über mikrobiologische Kriterien für Milch und Milchprodukte,Gutachten des Ständigen Hygieneausschusses,Bundesministerium für Gesundheit und Frauen, November 2006, according to Pei et al., 2011)

The main parameters controlled in the dairy industry are temperature and time of processing. Two critical control points (CCP) normally identified during the processing of milk are reception and the heat treatment step (pasteurization or sterilization) used to reduce microbial load.

In accordance with HACCP principles, the efficacy of these steps has to be verified on a periodic basis, among else through laboratory analyses of appropriate samples. Details are provided below:

CCPs for raw milk: upon delivery, before processing and following heat treatment
Tests carried out on raw milk: (a) microbial counts (upon delivery and before processing), (b) somatic cell counts (upon delivery) and (c) tests for Listeria and enterobacteria (following heat treatmemt).

CCPs for milk powder: immediately after production, at end of production and MHD (expiration date)
Tests carried out on milk powder: (a) Listeria (upon production), (b) Staphylococci and enterobacteria (at end of production process) and (c) Samonella and mould (at MHD).

2.5.2 GlobalGAP standard in the dairy sector

GlobalGAP, previously known as EurepGAP, has been established by the European-Retail Working Group, originally an association of German, Dutch and British retailers. More than 40 retailers from 15, mainly Western European, countries require their suppliers to be GlobalGAP certified (GlobalGAP, 2010, according to Herzfeld et al., 2011). As shown in Figure 2.5, GlobalGAP refers to the pre-farm gate on agricultural production (Lee, 2006).

According to the general regulations of GlobalGAP, the certification of dairy automatically requires compliance with the “Dairy Base”, “All Farm Base”, “Livestock Base” and the “Ruminant Base” Module (General regulations, 2011). Each module provides more specific control points on dairy health, milking and milking facilities. Some criteria are “Major Must” control points and need 100% compulsory compliance. Additional control points apart from the general concept of QA systems (section 2.4) include general requirements, cleaning agents and chemicals, medicines, worker hygiene, worker health, safety and welfare, Waste management, and environment and conservation. The specific requirements are described below according to the “Control Points and Compliance Criteria” of GlobalGAP (www.globalgap.org).

General requirements

- Site management. A risk assessment is needed for new or existing sites, which take into account the impact of production, food safety, environment and animal health.
- Legal registration. All dairy farmers are needed to register with relevant competent authority.
- Identification system. A movement record of dairy cattle confirms the date move to/from farm; numbers moved; identification marks (tags/chips/tattoos/batch ID); address to or from where they have been moved. All dairy cattle must have individual identification.
- Fallen stock disposal. Carcasses must be protected from vermin, birds or other animals, and must be promptly disposed of through burial, digestion, or incineration procedures in accordance with legal requirements.

Dairy health

- Veterinary health plan (VHP). Routine preventative treatments are shown such as foot care, mastitis prevention, vaccination, and worming programs. The VHP should be formulated, implemented, reviewed and updated at least annually.
- Veterinary visits. All dairy cattle should have a named veterinary surgeon or practice that visits must take place on at least an annual basis.
- Isolate sick or injured livestock. Each farm should be equipped with suitable facilities to isolate sick or injured livestock.
- Handling. Dairy cattle at all times should be treated and handled in such a way to protect them from pain, injury and disease.

Milking

- Cows in milk. Cows in milk are needed to milk regularly.
- Cows in withdrawal period. Milk from cows within the withdrawal period for any medicine is disposed of and does not enter the food chain. Also, milk from individual cows should not enter the collection system until it has been inspected for abnormalities or infection.
- Cleaning. Clean running water for cleaning of dirty cows, rump bars and floors during milking and potable water for cleaning of milking machines are needed.

Milking facilities

- Milking equipment. Milking equipment is needed to test once a year with records to ensure the temperature of adequate potable water used in the wash cycle and the cleaning chemicals used in the equipment.
- Milking parlor. (1) no evidence of vermin, birds or domestic pets; (2) no potential hazard of glass contamination from vulnerable lights; (3) walls, doors and floors are easily cleanable; (4) sufficient lighting for cows to see and function efficiently; (5) external doors and windows are sound and weather-proof; (6) no mess or rubbish as harborage for vermin; (7) clean equipment; (8) no excessive dust, no smoking; (9) well drained floors.

- Cooling equipment. Milk needs to be cooled to less than 8°C if stored for over 2 hours from the time of milking and less than 6°C if not collected daily.
- Area for vehicles. An area of well-drained hardstanding adjacent to the parlor is needed to facilitate vehicles. The areas should keep clean to prevent contamination.

Cleaning agents and chemicals

- Instructions. Instructions for use should be strictly followed where chemicals, pesticides or cleaning agents are used.
- Source. Only chemicals which are registered by official bodies for use on a dairy farm should be used in the milking plant or in the buildings.
- Storage. Chemicals should be stored in a clean and dry manner and in a secure store, remote from the milking facilities.

Medicines

- Source. Only use medicines that are approved for use by the relevant competent authority in the country.
- Residue testing. Regular residue tests should be carried out for the use of prohibited and permitted substances. The national scheme should transmit the data back to the farmer wherever Maximum Residue Levels (MRLs) are exceeded or a prohibited substance is detected.
- Medicine records. All farms should maintain up to date purchase records. Administration records for use of medicine should be held include the batch number, date administered, number of dairy cattle treated, total quantity of medicine used, date treatment finished, date withdrawal period completed and name of the person who administered the medicine.
- Medicine storage. Medicines should be stored with label instructions in original container with original label. The access to the sore should limit to workers with adequate training and experience in the handling of medicines.

Worker hygiene

- Garments. Clean suitable garments should be worn by those involved in the milking process. Protective clothing should be cleaned after use and stored.
- Wounds dressing. All wounds should be dressed.
- Disease. Workers suffer from notifiable disease should keep away from all aspects of work in and related to milking parlor.
- Clean arms and hands. Dairy persons should have clean arms and hands.

Worker health, safety and welfare

- Hazards and first aid. Permanent accident procedures must be clearly displayed in accessible and visible locations. Warning signs must indicate potential hazards.
- Worker welfare. Documentation is available that demonstrates that a named member of management has the responsibility for workers' health, safety and welfare.

Waste management

- All litter/waste should be cleared up. A Waste and Pollution Action Plan with adequate provisions for waste disposal is recommended.

Environment and conservation

- The producer should consider how to enhance the environment for the benefit of local community and minimize environmental impact of the agricultural activity. The producer should also monitor where and how energy is consumed on the farm.

2.5.3 BRC standard in the dairy sector

The BRC standard was developed in 1998, to respond to the needs of UK retailers and brand manufacturers. However, the standard has gained popularity globally (e.g. in Europe and North America) (Mensah and Julien, 2011). The BRC standard as a post-farm gate standard (Figure 2.5), which directly towards processors (Herzfeld et al., 2011), is in particular focused on food processing and food distribution. With a BRC certificate, manufacturers satisfy all that British supermarkets demand at once (Lee, 2006). Likewise, retailers in European countries now also demand from their suppliers for inspections according to BRC rules and for accompanying quality reports (Trienekens and Zuurbier, 2007).

Besides the general concepts of QA systems and the GlobalGAP standard (focuses on primary production), the norms of BRC standard take a HACCP system-based approach and lay more emphasis on managerial aspects and transportation for dairy processing companies. The norms that overlapped between BRC and previous requirements in this chapter are excluded from the following states. The BRC norms are described according to Global Standard for Food Safety (2011).

Senior management commitment

- Meeting programme
  The company should have a meeting programme which enables food safety and quality issues to be brought to the attention of senior management at least monthly. The senior management shall ensure that all employees are aware of their responsibilities.

Food safety and quality management system

- Quality manual
  Company should document food safety and quality manual that all procedures and work instructions shall be detailed to enable their correct application by appropriate staff.
- Documentation control and record maintenance
  The company shall operate an effective document control system to ensure that only the correct versions of documents, including recording forms, are available and in use. The particular clauses are shown in Appendix 3.

- Management of outsourced processing
  The company shall establish inspection and test procedures for raw milk from suppliers with contracts, including visual, chemical and microbiological testing, dependent on risk assessment. The contracts should clearly define any processing requirements. Also, the product traceability should be maintained.
- Corrective action
  The company shall be able to demonstrate that they use the information from identified failures in the food safety and quality management system to make necessary corrections and prevent recurrence (Appendix 3).
- Control of non-conforming product
  The company shall ensure that any non-conforming product is effectively managed to prevent release (Appendix 3).
- Traceability
  The company shall be able to trace all raw material product lots (including packaging) from their supplier through all stages of processing and dispatch to their customer and vice versa (Appendix 3).
- Complaint handling
  Customer complaints shall be handled effectively and information used to reduce recurring complaint levels (Appendix 3).
- Management of incidents, product withdrawal and product recall
  The company shall have a plan and system in place to effectively manage incidents and enable the effective withdrawal and recall of products. The product withdrawal and recall procedures (Appendix 3) shall be tested at least annually to ensure their effective operation.

Site standards

- Security
  Security systems shall ensure that products are protected from theft or malicious contamination whilst under the control of the site.
- Layout, process flow and segregation
  The factory layout, flow of processes and movement of personnel shall be sufficient to prevent the risk of product contamination.

Dispatch and transport

- Documented procedure
  The procedures to maintain product safety and quality include: (1) controlling temperature; (2) the use of covered bays for vehicle loading/unloading; (3) securing loads on pallets; (4) inspection of loads prior to dispatch.
- Traceability
  There shall be a clear record of dispatch and receipt of goods and materials demonstrating that sufficient checks have been completed during the transfer of goods.
- Inspection on vehicles and containers with records
  All vehicles and containers used for dispatch shall be inspected prior to loading to

ensure that they are: (1) in a suitably clean condition; (2) free from strong odors; (3) suitably maintained to prevent damage to products during transit; (4) equipped to ensure temperature requirements.

- Temperature control
  Temperature data-logging devices to confirm time/temperature conditions shall be used and record maintained.
- Cleaning procedure
  Documented cleaning procedures shall be maintained for all vehicles and equipment used for loading/unloading.
- Security during transport
  Clear instructions in the case of vehicle breakdown, accident or failure of refrigeration systems which ensure the safety of products is assessed and records maintained.
- Third-party contractors
  All the requirements specified above shall be defined in the contract and verified.

Product and process control

- Laboratory product testing
  The company shall undertake or subcontract inspection and analysis which are critical to confirm product safety and quality. The particular causes regarding laboratory testing are shown in Appendix 3.
- Control of operations
  The company shall operate to documented procedures and work instructions that ensure the production of consistently safe and product with desired quality characteristics, in full compliance with the HACCP food safety plan.
- Calibration and control of measuring and monitoring devices
  All identified measuring devices, including new equipment, shall be checked at a predetermined frequency based on risk assessment to provide accurate and reliable measurement results.

2.6 Implementation of quality assurance systems

This section will answer the research sub question 2.c "*What are the indicators extracted from the implementation of QA standards in different regions of the world?"*

Over the past decade, quality assurance has become a cornerstone of food safety policy in the food industry (Beulens et al., 2005). The application of QA systems helps in identifying and managing the quality hazards and risks occurring in the production process, and in providing the consumer with more certainty about the quality of products of animal origin (Noordhuizen and Metz, 2005). However, the way in which food industry decides to comply with regulations is influenced by a range of different factors. In implementing QA systems, many problems are becoming acute to achieve the QA standards and various studies have examined the barriers that prevent compliance. Therefore, key factors that drive China's dairy sector towards compliance are necessary to evaluate in this section.

Kupper and Batt (2009) argued that the barriers and constraints to the adoption of QA systems can be grouped into two main categories: internal barriers and external barriers. Since the process of implementing QA programs is a complicated procedure where different constrains appear at different stages. The barriers must be acknowledged and addressed in the evaluation framework to validate the adoption of QA programs.

2.6.1 Internal barriers

The two groups of internal barriers that may affect adoption of QA systems include resource barriers and general barriers:

Resource barriers

- Training

  Lack of human resource is the main barrier to the adoption of QA systems. Lack of managerial capability and reliable advice from the leadership can impact adversely on the ability of the firm to adopt new technology and to innovate (Kupper and Batt, 2009). Holt and Henson (2000) conducted investigation on small meat manufacturers reported that problems in the management of QA were more likely to occur with the employment of a production manager who was not responsible or trained for QA responsibility. Payne et al (1999) stated that training at all levels were encouraged, including the milker based on their on-farm QA survey. In-house training was more prevalent amongst companies. It increased staff motivation because it was a more acceptable environment than a classroom, and could be tailored to specific employee needs (Holt and Henson, 2000). In addition to the regular short training courses to increase knowledge of workforce on food safety, additional knowledge is required for professionals that maintain and continually improve the system (Mensah and Julien, 2011).

- Staff time

  Assurance activities are long term based and companies are difficult to implement time-consuming programs (Sporleder and Goldsmith, 2011, according to Sampers et al., 2012). Typical small business has a busy, day-to-day existence without designated staff to get involved in long term planning activities. It is evident that even if the owner-manager can be convinced of the need to implement and maintain one or more QA programs, the allocation of sufficient time for the development and update is a constraining factor (Kupper and Batt, 2009).

General barriers

- Documentation and record keeping

  Documentation aims at keeping knowledge and information, whereas record keeping aims at collecting data (Luning et al., 2009). They are essential for QA because it supports a transparent system and enables stakeholders (government, auditors, certification authorities, etc.) to evaluate and certify the system, which contributes to providing confidence (Duxbury, 2005; Jacxsens et al., 2009; Walker and Jones, 2002,

according to Luning et al., 2009). Holt and Henson (2000) investigated the application of QA management in meat manufacturers indicated a lack of understanding of how the documented system operates. The documentation and records could be easily falsifies — Large companies with fully documented hygiene systems can have low standards of cleanliness. One surveyed manager in that research assumed that documentary control could not be guaranteed by formalizing procedures in writing.

2.6.2 External barriers

With respect to external barriers, food industry needs support and guidance to implement QA systems. Additional costs for obtaining certification may also affect adoption.

Guidance barriers

- Support schemes

  Nearly all companies surveyed by Holt and Henson (2000) lacked a formal and forward-looking QA program, especially for small companies. Food consultants trained in QA systems can therefore provide a useful service by locating technical aspects of quality management into a conceptual framework (Holt and Henson, 2000).

- Sector specific implementation

  Herzfeld et al (2011) stated that the QA standards developed against a European background miss a capability to be adapted to local conditions. Furthermore, Sischo et al (1997) argued that the QA programs did not provide adequate tools for the producers to develop plans to manage and monitor changes that were specific to their own farms. Producers were not convinced that practices used to avoid residues were integral to successful dairy production. To tailor assurance activities for company specific characteristics will be a more severe challenge for smaller companies.

Certification barriers

- High costs of certification

  The costs for China's agri-food exporting enterprises in complying with foreign food safety regulations were investigated through surveys by Song and Chen (2010) during the year of 2008 and 2009. The results showed that the total compliance costs increased over time in China. Building renovation, technical innovation, and testing equipment were major components of total compliance costs (Figure 2.7).

Unit / Costs	2006		2007		2008	
	Costs	Ratio in total compliance costs	Costs	Ratio in total compliance costs	Costs	Ratio in total compliance costs
	000s of ¥	%	000s of ¥	%	000s of ¥	%
Procedural fee of obtaining the certificate or registration	42.27	0.35	42.27	0.4	42.27	0.23
Annual fees on certification or registration	86.63	0.72	86.63	0.82	86.63	0.46
Testing Fees	1662.57	13.76	1730.85	16.4	3328.54	17.78
Costs on building renovations, lab equipments, training, and others	10291.96	85.17	8694.03	82.38	15265.72	81.53
Total Costs	**12083.43**	**100**	**10553.78**	**100**	**18723.16**	**100**

Figure 2.7 Average compliance costs to food safety regulations in China

2.7 Evaluation framework

In this section the research question 2 "*What is an evaluation framework to assess food quality and safety performance of entire China's dairy chain?"* will be answered.

Section 2.4, section 2.5, and section 2.6 have presented all the indicators of the evaluation framework. Figure 2.8 shows an overview of indicators concerning both managerial and technological aspects. The derived areas and indicators from main QA concepts (Appendix 1) form the basis of the framework. QA standards (HACCP, GlobalGAP, and BRC) provide more indicators in the dairy sector and in the specific milk powder processing line. Additional indicators derived from the application of QA systems in food industries complement and perfect the evaluation framework.

The evaluation framework contains 13 areas and 83 indicators, covering the entire dairy supply chain toward both managerial and technological aspects (Figure 2.8). However, 83 indicators are far too much to conduct an in-depth investigation of food safety activities in China's dairy sector. Additionally, some of the managerial indicators focus more on how to apply QA systems better rather than food quality and safety requirements. For example, the indicator "availability of time" is used to examine the allocation of sufficient time for implementing and maintaining one or more QA systems rather than ensure food safety directly. Therefore, areas and indicators that are the most important to food quality and safety are selected based on the following criteria:

(1) Areas and indicators that undertake the responsibility of melamine crisis. The raw milk collection station was the crime site of melamine adulteration. And no single government agency had clearly identified responsibility for controlling the numerous private raw milk collection stations (Chen, 2009). Moreover, Sanlu Company (main crime company) officials had known about the problem for months and possibly as far back as December 2007 without taking any corrective actions (Xiu and Klein, 2010).

(2) Areas and indicators that are core assurance activities from QA concepts. On a management level decisions in controlling safety and quality along the food production chain have to be made on the extent of sampling and the number of critical control points (Luning et al., 2006).

(3) Areas and indicators that are CCPs of HACCP system. Schothorst and Kleiss (1994), Arvanitoyannis and Mavropoulos (2000), and Vilar et al (2011) identified the CCPs in the dairy industry and specific milk powder processing lines aiming at ensuring food quality and safety.

(4) Areas and indicators that are "Major Must" control points in "Dairy Base" and "Livestock Base" of GlobalGAP standard.

(5) Areas and indicators that are "Fundamental requirements" of BRC standard or crucial

to an effective performance of food quality and safety.

(6) Areas and indicators that are barriers to the adoption of QA systems. The barriers are key problems in China's dairy sector exposed by the melamine crisis. E.g. dairy farmers are not trained properly and no detailed national standards that cover specific aspects of dairy chain (Xiu and Klein, 2010).

In accordance with the selection criteria, a total of 31 indicators covering 10 major areas are chosen (Appendix 4):

- Decision-making on QA (3 indicators). "*Identify critical points*" and "*Validation at critical points and monitoring systems*" are core assurance activities that affect food safety performance. "Traceability" is a fundamental requirement of BRC standard.
- Quality behavior (2 indicators). "*Training*" and "*Support schemes and supervision*" are two main barriers to the application of QA systems.
- Auditing and certification (3 indicators). "*Sampling & laboratory testing*" is a core assurance activity that affect food safety performance. "*Documentation/record*" is a barrier to ensure food safety transparent during the adoption of QA systems; it is also a fundamental requirement of BRC standard. "*Corrective action*" is a fundamental requirement of BRC standard; it also causes the melamine crisis because the melamine adulteration had known for months by the company without taking any corrective actions before the scandal (Wang, 2009; Xiu and Klein, 2010).
- Farming practices (2 indicators). "*Identification system*" is a Major Must control point in the Livestock Base of GlobalGAP standard. "*Animal health*" is a Major Must control point in the Dairy Base of GlobalGAP standard.
- Collection stations (8). All the indicators from the stage of collection stations are selected because this stage is the crime site of melamine adulteration and they are all Major Must control points of GlobalGAP standard.
- Distribution (2 indicators). The purpose of BRC requirements on dispatch and transport is to ensure the vehicles and containers used for transporting do not present a risk to safety or quality of the products (Global Standard for Food Safety, 2011). So the "*Cleaning procedure*" is especially important to eliminate risks of food safety. "*Inspection prior to/during transportation*" is a CCP of HACCP system.
- Milk reception (4 indicators). All the indicators refer to milk reception are selected because this step is a CCP of HACCP system.
- Transformation (5 indicators). All the indicators relate to pasteurization from transformation stage are chosen based on HACCP system.
- Retail practices (1 indicator). "*Traceability*" in the stage of wholesalers/retailers is required by HACCP system.
- Final food preparation (1 indicator). "*Expiration date*" is a CCP of HACCP system for milk powder.

Chapter 3 describes the methodology used in benchmarking food quality and safety activities in China's dairy chain according to the evaluation framework.

Fig. 2.8 **Overview of indicators along the dairy supply chain for QA (Based on Luning and and Marcelis, 2009)**

Managerial aspects on quality assurance

Organizational change conditions

• Change strategy • Meeting program • Quality manual

Decision-making on QA

- Identify critical points
- Validation at critical points and monitoring systems
- Assembling project team
- Responsibilities and procedures in quality systems • Outsource
- Complaint handling • Security
- Animal welfare • Traceability
- Worker health, safety, welfare
- Waste management/environment

Quality behavior

Disposition

- Quality knowledge
- Training
- Information
- Observed standards of company
- Workplace climate

Ability

- Skills and competence
- Availability of time
- Availability of personnel
- Support schemes and supervision
- Costs and resources

Auditing and certification

- Internal audit (audit procedure, audit criteria)
- Sampling& laboratory testing
- Calibration
- Corrective action
- Control non-conforming product
- Product recall
- External audit (certification)
- Documentation/record

Technological aspects on quality assurance

Primary production

Farming practices

•Site management •Legal registration •Identification system •Breed choice •Feeding (amount & composition & cleaning) • Medicine storage • Animal health (VHP, isolate sick cows, handling) • Animal welfare • Housing conditions • Fallen cows disposal

Collection stations

•Regularly milking •Cows in withdrawal period •Worker hygiene •Milking (teat hygiene, stirring, acidity，temperature) •chemicals • Parlor condition (vermin, lights, walls, doors, floors, rubbish) • Milking/cooling equipment hygiene • Clean potable water

Distribution

• Inspection prior to/during transportation (duration, temperature, acidity) • Cleaning procedure • Documentation/record procedure • traceability • Third-party contract • Security during transport

Dairy processing

Milk reception

- inspection (temperature, acidity, penicillin)
- Hygienic conditions during milk reception
- Filtration
- Storage (time & temperature)

Transformation

- Heating time & temperature
- Cooling (leaks, pressure)
- Equipment design
- Cleaning and disinfection of equipment • Factory layout

Packaging

- Aseptic packaging integrity • Material
- Hygienic condition
- Temperature
- Appropriate labeling

Storage products

- Hygiene conditions
- Temperature
- Relative humidity

Distribution

Retail & Final food handling

Retail practices

• Temperature • Hygiene conditions in storage area • Duration • Packaging integrity • Handling of personal • Traceability

Final food preparation

• Conditions of storage equipment • Expiration date • Hygienic circumstances • Cooking conditions

3. Methodology

After literature study in chapter 2, the first two steps of benchmarking model were carried out — Depiction of Chinese dairy chain, target dairy product identification, and the formulation of evaluation framework. The third step of benchmarking model is data collection in order to validate food quality and safety activities performed in China's dairy chain. It is complemented with survey methodology that combines quantitative (questionnaire) and qualitative (in-depth interview) methods.

Section 3.1 describes the target dairy industry in this survey. Section 3.2 develops the questionnaire with indicators selected from evaluation framework. Section 3.3 guides the main topics of in-depth interview. Section 3.4 gives a description of the classified respondents. And section 3.4 explains the survey procedure step by step.

3.1 Target dairy industry

This survey only covers the highly modern processors in China's dairy sector, which have the best chance to comply with EU standards and make the export of milk powder to the EU possible.

An Industrial Policy for Dairy Industry was revised in 2009 by National Development and Reform Commission. Chinese dairy industry was divided into 5 districts:

(1) Northeast and Inner Mongolia district, including Heilongjiang, Jilin, Liaoning and Inner Mongolia (4 provinces). This district is the important base of raw milk source and dairy production.
(2) North China district, including Hebei, Shanxi Shandong and Henan (4 provinces). This district has good processing condition but relatively low capacity.
(3) Northwest district, including Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang (6 provinces). Milk cattle breeding skill is backward in this district.
(4) South China district, including Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou and Yunnan (13 provinces). Milk output in this district is very low.
(5) District that around modern cities, including Beijing, Tianjin, Shanghai and Chongqing. This district has modern technology, high capacity, and big markets. It supports the research of dairy processing technology to upgrade the industry and encourages developing new dairy products.

The target dairy industry only refers to highly modern dairy industry in China. Based on the above distribution, two districts can be considered as target dairy districts in this survey: "Northeast & Inner Mongolia district" and "District around modern cities". As the main base of dairy processing and production region, "Northeast & Inner Mongolia district" has seen rapid growth. Foreign technologies have been used extensively and advanced processing plants have been constructed. While the "District that around modern cities"

was the first district to develop dairy industry which had been influenced by the consumption habits of foreigners in 1956, urban dairy enterprises had since developed sophisticatedly. The developments of the other three districts have been restricted by the undeveloped economies and the limitation of grassland.

Initially the practice of raising dairy cattle was to meet the demand for dairy products by foreigners in the territory of China. Most of dairy cattle were directly transported from Europe to China. The early urban dairy industry was concentrated in the large cities where most foreigners inhabited (Chen et al., 2008). Urban dairy processing enterprises in cities such as Beijing, Tianjin, and Shanghai have since developed sophisticated with high quality and safety. Therefore, dairy chains in these cities were selected as target dairy industries in the survey.

Since the mid-1980s, northeast agricultural regions gradually become the major source of raw milk for dairy processors in China, especially those located in Inner Mongolia. The total output of Northeast district jumped to 18 million tons in 2006, which is more than half of the national total output (Chen et al., 2008). So, dairy chains in Hohhot (the capital city of Inner Mongolia) from "Northeast & Inner Mongolia district" can be considered as another target in this survey.

As a consequence, the survey covers 4 cities: Hohhot from "Northeast & Inner Mongolia district"; Beijing, Tianjin and Shanghai from "District around modern cities".

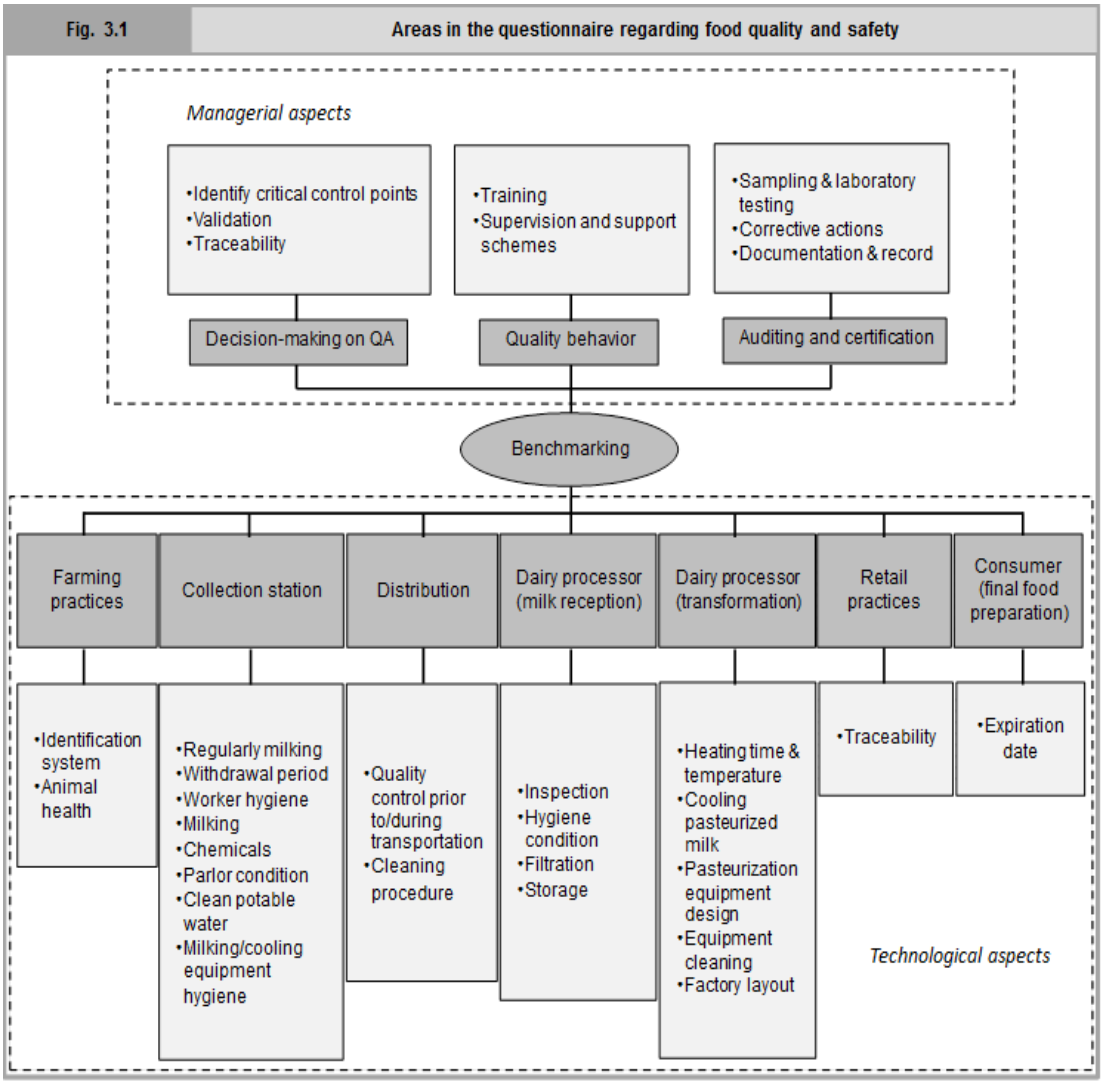
3.2 Questionnaire design

A questionnaire (Appendix 5) was developed for the research sub question 3: "*To what extent does China's dairy chain comply with extracted food quality and safety indicators?*" Indicators in the questionnaire formulated a checklist with 4 level scales to benchmark the food quality and safety performance of China's dairy chain.

The indicators in the questionnaire followed the evaluation framework (section 2.7) with respect to both managerial and technological aspects in quality assurance. A total of 31 indicators were developed in the questionnaire covering 10 major areas regarding food quality and safety: (1) decision-making on QA (n=3 indicator); (2) quality behavior (n=2); (3) auditing and certification (n=2); (4) farming practices (n=2); (5) collection stations (n=8); (6) distribution (n=2); (7) milk reception (n=4); (8) transformation (n=5); (9) retail practices (n=1); (10) final food preparation (n=1). These 10 areas covered every stage of entire dairy chain (Figure 3.1).

The evaluation framework was based mainly on the techno-managerial approach developed by Luning et al (2006). It is aimed to recognize both technological and managerial aspects with respect to the assurance of food safety. This techno-managerial approach was further applied to several studies to measure the food safety performance in agri-food chain (Jacxsens et al., 2010) and milk processing plants (Sampers et al.,

2012). In those studies, the validation of indicators for the core control activities (technology-dependent and managerial activities) was scored by four different levels, which represented not applied (score 0), low (score 1), medium (score 2), and high food safety output (score 3). These four different levels as well as the data processing method were also applied in this research.



Five different levels have been described for each indicator. Score 0 (no indication of food safety activity) referring to absent, not present, not conducted. Score 1 (low level of validation) is associated with activities that based on own experience, not standardized, unstable, problem driven, scarcely reported, no independent positions, and regularly problems. Score 2 (medium level of validation) is referring to activities that use of (sector, governmental) guidelines, based on expert knowledge, standardized, regular reporting, and restricted problems. Score 3 (high level of validation) is referring to activities that use specific information/criteria, scientific knowledge, systematic activities, independent positions and have no safety problems. A score 4 (Don't know) means the validation of specific food safety activity is not known by the respondent. Based on the scores for the individual indicators, an overall score and assigned score can be defined to give an

overall judgment of the food quality and safety performance of the current China's dairy sector (Sampers et al., 2012; Jacxsens et al., 2010). Open-ended questions that asked about concerns related to challenges and possible solutions of dealing with these challenges were included in the questionnaire. Extra space was provided at the end of the questionnaire for additional comments.

The questionnaire was developed in English and sent out with Chinese translation and explanation. The cover page of the questionnaire included a survey explanation and a short guidance for questionnaire fulfillment.

3.3 Interview design

In-depth interviews were developed due to the sensitivity and complexity of the research sub question 4 "*What are the key challenges to upgrade the quality and safety of China's dairy chain?*" and 5 "*What policies or strategies are developed to improve the quality and safety of China's dairy chain?*" The interview guide covered the following topics:

- The key challenges to upgrade food quality and safety of China's dairy chain
- The policies or strategies can be developed to improve food quality and safety of China's dairy chain

The interview started with the question why the respondents give low scores to specific indicators, and the possible solutions for each lower scored indicator to improve food quality and safety performance.

Then the interview continued with the fact that the EU banned Chinese milk products since 2002:

> *The import in the EU of milk products from China has been prohibited under EU legislation since January 2002, saying that the Chinese residue pesticide system did not reach standards set down by the EU, to what degree do you think the residue pesticide system has been improved?*

Next, the suggestion of change strategies and main barriers (costs, sufficient time, and tailor EU assurance activities for specific characteristics of China's dairy chain) that affect the adoption of QA systems were discussed.

> *Do you think the application of QA systems in China will cause resistance to change? Which change strategy is more suitable to China's dairy industry, force-coercion with rewards and punishments, rational persuasion depends to expert power or shared power with high level of employee involvement?*

> *Are the cost and sufficient time involved in implementing and continually maintaining QA system and tailor EU assurance activities for specific*

characteristics of China's dairy chain barriers?

The interview ended with a question on whether the interviewee has something to add.

Do you have something to add in this interview?

All the interviewees refused the sound recording. The interview content was later fully translated into English.

3.4 Respondents

The respondents can be divided into the following five groups: (1) researchers from university and research institute; (2) staff members of government; (3) staff members of certification agency; (4) members of dairy association; (5) staff members/workers in highly modern dairy company.

- Experts who carry out dairy research in universities and institutes can give an insight view into quality and safety of milk powder production. Especially after the melamine crisis, many researchers are committed to improve food quality and safety in China's dairy chain.
- Staff members from authorities, particularly from the MOA (Ministry of Agriculture) and the AQSIQ (Administration of Quality Supervision, Inspection and Quarantine) which administer production and official control respectively, can give an overview of present status of China's dairy industry based on their supervision. Statements could be made on how to implement the duty of improving food quality and safety in China's dairy sector.
- Staff members from certification agency might have a good understanding of the degree to which milk powder production in China complies with QA systems (HACCP system, GlobalGAP, and BRC standards). They can also point out the weak points of China's dairy chain on the basis of their investigation.
- Members of dairy association can give insightful views on different stages of China's dairy chain with respect to food quality and safety and propose practical policies for the improvement.
- Staff members or workers from highly modern dairy companies can provide specific information about how the raw milk and milk powder production was operated according to food quality and safety requirements in dairy farms and the processing lines.

The contact information has been acquired through certain channels. For example, the websites of authorities, certification agencies, and associations provide telephone numbers, and some food science journals leave e-mail address of the authors. Other ways like the professor/students who work/study in a university in the dairy field introduced more experts. The respondents have been invited over phone or e-mail to participate in the research. The purpose of the survey and the expectation from the

respondents were explained. Contact details of respondents who were willing to participate further were collected for a detailed investigation.

Altogether 50 respondents accepted the invitation to participate in this investigation through e-mail or telephone.

(1) Researchers from university or research institute (n=23)

- Universities: 21 experts in dairy sector were from universities. The chosen universities were not confined to the 4 target cities.
- Institute of Animal Science: 2 respondents.

(2) Staff members of government (n=6)

- MOA (Ministry of Agriculture) – Milk and Dairy Product Inspection Center (Beijing): the deputy director was visited as the only interviewee from MOA.
- Tianjin Bureau Quality and Technical Supervision (Tianjin): 5 inspectors who were responsible to inspect quality and safety of dairy products.

(3) Staff members of certification agency (n=0)

Three certification agencies were contacted, but the questionnaire seems to be too specific for them. Since their business are laboratory testing and mostly on fruits and vegetables, they know less about dairy and milk production. They have no case about GlobalGAP or BRC certification for dairy products. No respondent was participated from this group.

(4) Members of dairy association (n=5)

- Dairy Association of China: 3 respondents.
- China Dairy Industry Association: 1 respondent.
- Shanghai Dairy Association: 1 respondent.

(5) Workers in highly modern dairy company (n=16)

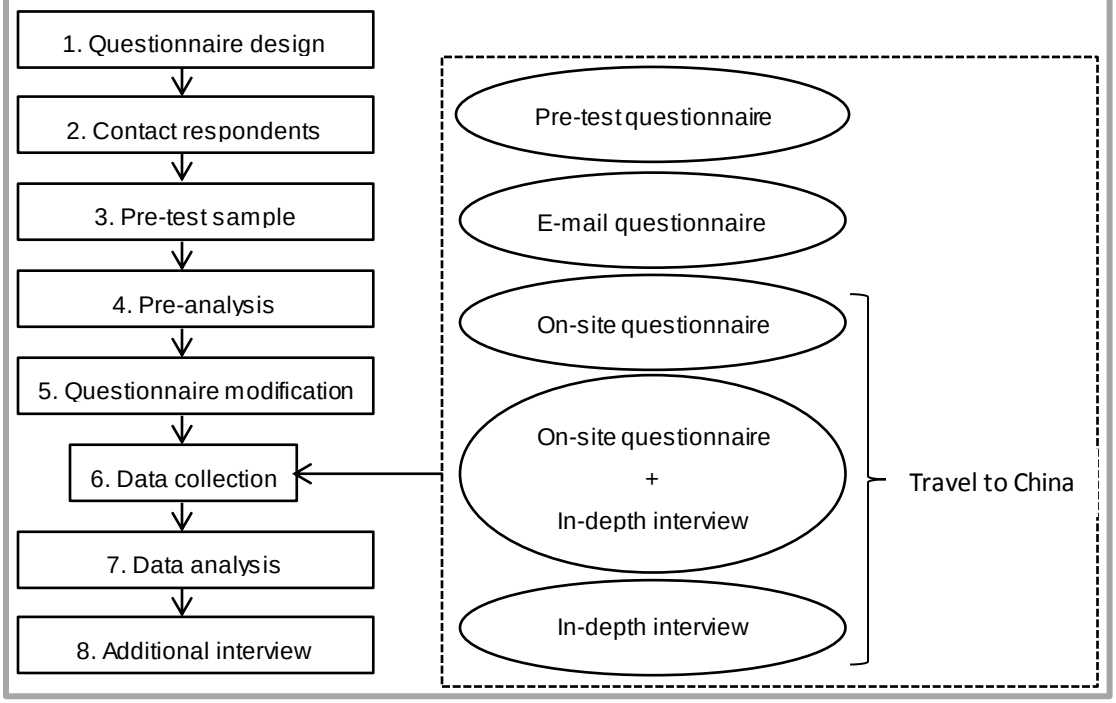
The top four dairy companies based on the sales report in 2009 are Mengniu Group (Hohhot), Yili Group (Hohhot), Bright Dairy (Shanghai) and Sanyuan Group (Beijing) (http://www.yz006.com/news/201011/25528_12.html). Their distributing of manufactories and capabilities are shown in Appendix 5. The respondents in this group are inspectors and quality controllers from these four dairy companies.

- Mengniu Group (n=4): Mengniu Group has become the leading dairy product manufacturer and the top seller of milk in China.
- Yili Group (n=6): Mengniu's main competitor in China. Yili Group is appointed as the only dairy products provider of Beijing Olympic Games and Expo 2010 Shanghai.
- Bright Dairy (n=3): China's third-largest dairy producer with pioneering creativity in the industry.
- Sanyuan Group (n=3): Sanyuan Group is the only listed dairy producer that has avoided being associated with China's milk contamination scandal in 2008, taking the opportunity to become one of the top brands.

3.5 Survey procedures

The survey was conducted in 8 steps. In a flowchart (Figure 3.2) it's easy to see how to gather data and make a sound investigation.

Fig. 3.2 **Survey procedures**



Step 1: A total number of 31 indicators covering entire dairy chain were developed in the questionnaire to evaluate the validation of food quality and safety activities in China's dairy chain.

Step 2: The respondents were invited in advance over phone or e-mail to make sure they can participate in this research.

Step 3: A questionnaire pretest was conducted. Three selected experts from universities were asked to send back the finished questionnaire with their comments by e-mail.

2 out of 3 pre-test questionnaires have been received. According to the feedback, some requirements from the questionnaire were not in conformity with Chinese practice or local condition. For example, indicator B 3.1 stated that "Prior to raw milk transportation the driver monitors the temperature and acidity of milk", while the fact is that usually the inspectors in charge of quality control in China and not the drivers. So the questionnaire was in need of revision.

Step 4: Received pre-test questionnaires were analyzed to see whether the questionnaire was able to reflect food quality and safety performance of China's dairy chain.

Step 5: To ensure the description of indicators in the questionnaire is transparent, accurate, and conformable to local condition, the questionnaire was revised (Appendix 4) to clarify the precise meaning of terms and regulate the translation of technical information. The final version of questionnaire was distributed to the respondents who were supposed to complete the questionnaire by e-mail.

Step 6: The primary data was gathered by consulting experts. A small scale questionnaire and individual interviews were carried out.

- For most of the researchers from university and institute, the questionnaire was distributed by e-mail. Some of them were selected to have a face-to-face interview based on their responses to the questionnaire. For the researchers who were also invited to further involvement in the in-depth interview, on-site questionnaire and interview were conducted at the same time.
- For the staff members/workers from highly modern dairy company, on-site questionnaire was carried out because of the necessary personal instruction.
- For the respondents from government and dairy association, an on-site questionnaire was conducted in parallel with in-depth interview considering the low response with e-mail contact.

Step 7: Based on the scores for individual indicators from received questionnaires, an overall score and assigned score can be defined to assess food quality and safety activities in China's dairy chain. The derived challenges and policies to upgrade food quality and safety of China's dairy chain were reported according to the interviews.

Step 8: For the questions needed to be discussed with experts again, additional interviews could take place.

The next chapter discusses the extent to which China's dairy chain compliance with the assessed indicators and accompanied by potential challenges and solutions.

4. Results

This chapter is organized as follows. Section 4.1 describes the pre-test analysis which was mentioned before in chapter 3. Section 4.2 generally introduces how the survey was carried out (by on-site visit or by e-mail). Section 4.3 traces out the degree of the validation of food quality and safety activities in China's dairy sector according to the survey feedbacks. Section 4.4 then moves to the possible solutions to upgrade China's dairy chain according to the interviews. Section 4.5 elaborates the mutual relations between the survey and interviews. Section 4.3 and section 4.4 provide the answers to sub research question 3, 4, and 5. Namely, *"To what extent does China's dairy chain comply with extracted food quality and safety indicators?"*, *"What are the key challenges to upgrade the quality and safety of China's dairy chain?"*, and *"What policies or strategies are developed to improve the quality and safety of China's dairy chain?"*

4.1 Pre-analysis of questionnaire

Both two pre-test respondents scored 3 for most of the 31 indicators in the questionnaire. This means most of the food safety activities are validated in high level. No 0 score was given, which means all the food safety activities were performed in China's highly modern dairy industry.

For managerial aspects on quality assurance (8 indicators), score 2 (medium level of validation) was found in 3 indicators, namely "Identify critical control points", "Traceability", and "Documentation & record"; the low score 1 (low level of validation) was found in indicator "Supervision and support schemes". Above all, half of these managerial activities were not performed well according to the pre-test respondents.

For technological aspects on quality assurance (23 indicators), 5 indicators were scored 2: "Identification system", "Animal health", "Parlor condition", "Quality control prior to/during transportation" and "Expiration date". These lower scored indicators revealed that the medium level of validation occurred in the stages of farmers, milk collection stations, distribution, and consumers of the dairy chain.

The aim of the pre-test analysis is to see whether the questionnaire can be able to reflect week points of food quality and safety activities in the dairy chain. Based on the scores for specific managerial and technological indicators, this questionnaire can give an overall judgment of the validation of food quality and safety activities. Managerial problems exist and need to be solved in China's dairy sector. Possibilities are revealed to improve food quality and safety in the stages of farmers, milk collection stations, distribution and consumers.

4.2 Data collection

As stated in previous chapter, the target industry of this investigation was highly modern dairy industry in China. Four involved cities were Hohhot, Beijing, Tianjin and Shanghai. The geographical position of these four cities is marked in Figure 4.1. The schedule for data collection is shown in Table 4.1.

Figure 4.1 Locations of survey

The questionnaire covers four cities: Hohhot from "Northeast & Inner Mongolia district"; Beijing, Tianjin and Shanghai from "District around modern cities". The researcher traveled to these four cities for on-site questionnaire and in-depth interviews.

Table 4.1	Schedule for data collection		
Time	**City**	**Respondent**	**Activity**
25/11/2011	Beijing	China Dairy Industry Association	•On-site questionnaire •In-depth interview
28/11/2011	Hohhot	Inner Mongolia Agricultural University	•In-depth interview
29/11/2011	Hohhot	Mengniu Group	•On-site questionnaire
30/11/2011	Hohhot	Yili Group	•On-site questionnaire •In-depth interview •Plant tour
1/12/2011	Beijing	Sanyuan Group	•On-site questionnaire
5/12/2011	Tianjin	Tianjin Bureau Quality and Technical Supervision	•E-mail questionnaire
7/12/2011	Shanghai	Bright Dairy	•On-site questionnaire
8/12/2011	Shanghai	Shanghai Dairy Association	•In-depth interview
12/12/2011	Beijing	MOA – Milk and Dairy Product Inspection Center	•In-depth interview
15/11/2011 - 10/1/2012		•China National Milk Quality Center •Universities	•E-mail questionnaire

50 respondents were selected and contacted in advance to ensure their participation in the survey. In total 34 respondents really responded to the survey. The reason that respondents were unwilling to be involved was due to the delicate subject – Food safety of milk powder. For example, what they said was once exposed by news media that evoked mistrust of the public or they were not allowed to reveal the information related to specific dairy enterprise. Table 4.2 shows the detailed contributions of these 34 respondents. Totally 33 questionnaires were received and 66% of the questionnaire response rate. Respondent from "MOA – Milk and Dairy Product Inspection Center" only accepted

in-depth interview without filling in the questionnaire. The 33 respondents who completed the questionnaires came from four subgroups. The response rate of each subgroup and the proportion of each subgroup in the total received questionnaires are illustrated in Table 4.3.

Table 4.2	Detailed contributions of 34 respondents responded to the survey						
Activity/Group	University /Institute	Government	Association	Dairy company			
				Yili	Mengniu	Bright	Sanyuan
E-mail questionnaire	9	5	-	-	3	2	2
On-site questionnaire	-	-	-	4	1	1	1
On-site questionnaire + In-depth interview	-	-	1	2	-	-	-
Pre-test questionnaire + In-depth interview	1	-	1	-	-	-	-
In-depth interview	-	1	-	-	-	-	-
Total (34)	10	6	2	16			

Table 4.3	Characterization of the 33 respondents responded to the questionnaire		
Respondent type	Number of respondents	Response rate (%)	Ratio (%)
Researchers from university/research institute	10	43	30
Staff members of government	5	83	15
Members of dairy association	2	40	6
Workers in highly modern dairy company	16	100	49

4.3 Survey

In this section, the sub research question 3 *"To what extent does China's dairy chain comply with extracted food quality and safety indicators?"* will be answered by the levels of validation on indicators. The indicators with low level of validation will be used to answer the sub research question 4 *"What are the key challenges to upgrade the quality and safety of China's dairy chain?"*

In total 33 questionnaires were collected in target dairy sector from four subgroups. An overall picture of the validation of the food quality and safety activities in China's highly modern dairy industry is illustrated in Table 4.4 and Table 4.5. The frequency of the scores was given to perceive different levels of validation between indicators and to have an insight in possibilities to improve food quality and safety.

First, there was no respondent who marked a score 0 (No indication of activity), this means all food safety indicators are presented and conducted along the dairy chain. Second, relatively few respondents chose score 1 (Low level of validation). The validation on managerial aspects was clearly worse than the validation on technological aspects

because the score 1 frequency was much higher in managerial aspects. Third, score 2 (Medium level of validation) was typically associated with certain indicators: “Traceability (decision-making)”, “Training”, “Supervision and support schemes”, “Corrective actions”, and “Documentation & record” from managerial aspects; “Identification system”, “Animal health”, “Parlor condition”, “Quality control prior to/during transportation”, “Cleaning procedure”, and “Traceability (retail practices)” from technological aspects. Fourth, the majority of respondents gave score 3 (High level of validation) for each indicator, which represents specific information, scientific knowledge, systematic activities and having no safety problems. In particular, there was a number of incomplete information (score 4), this was because not all the respondents have a complete and adequate overview of various indicator impacts on food safety along the entire dairy chain.

The melamine scandal exposed serious food safety problems in China’s dairy sector. However, according to the questionnaire, most respondents gave score 3 which means no safety problems existed. Based on the author’s investigation, the fact of this matter should be assigned to uneven development in the front stages of the dairy chain, which affects the quality and safety of milk powder directly.

In order to ensure quality and safety of milk supplies, some large modern dairy processing enterprises (such as Mengniu, Yili, Bright and Sanyuan involved in this research) invest and construct their own pastoral parks near the processing plants. The characters of the pastoral park are that: (1) the milk processing enterprises construct the pastoral park directly and make investments in constructions and facilities; (2) the genetics of the dairy cows are good; (3) all the farm operations are accomplished by technical personnel trained by the enterprises; (4) most raw milk from pastoral parks are used to produce organic dairy products. Therefore, under the food safety management techniques, large modern dairy enterprises with their own pastoral parks are able to ensure the food quality and safety of raw milk. Considering the enterprises involved in the questionnaire were Top 4 dairy enterprises in China, the performance of pastoral park may account for the majority of high score 3.

However, it is important to note that the amount of raw milk from enterprises’ own pastoral parks might only accomplish one-third of their manufacturing capability (according to the interview with the expert from Shanghai Dairy Association). In most cases, private individuals who construct milk collection stations sell the raw milk to processing enterprises to meet the productive capacity and production requirements. The milk collection stations collect raw milk from the members of the collective farms, who are smallholders with low technical assistance on food quality and safety. This fact contributes to the lower scores (score 1 and score 2) in the questionnaire.

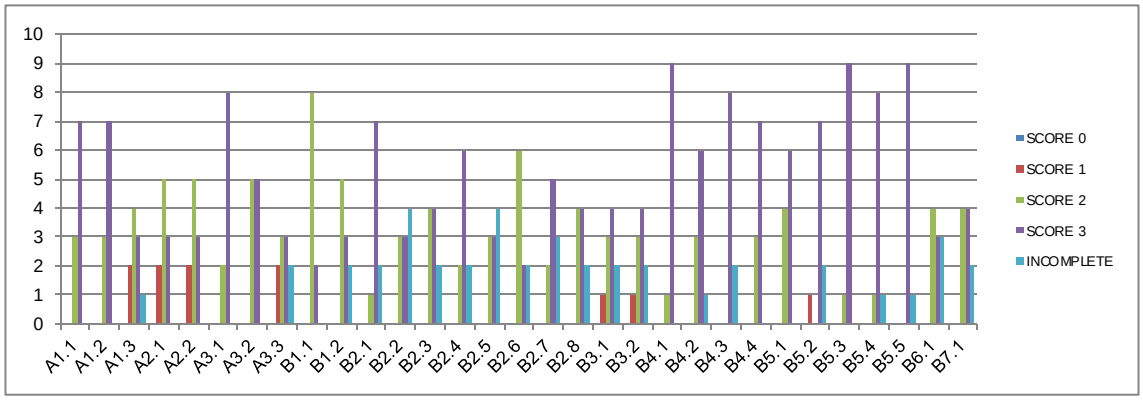
Table 4.4	Frequency of individual scores for managerial aspects on quality assurance (Score 0, 1, 2, and 3 represent no, low, medium, and high level; score 4 represent incomplete information)					
Managerial aspects	**Indicators**	**Frequency**				
		0	**1**	**2**	**3**	**4**
Decision-making	Identify critical control points	0	1	4	22	6
	Validation	0	0	5	24	4
	Traceability	0	2	11	12	8
Quality behavior	Training	0	2	13	17	1
	Supervision and support schemes	0	4	11	15	3
Auditing and certification	Sampling & laboratory testing	0	0	3	30	0
	Corrective actions	0	3	12	16	2
	Documentation & record	0	2	13	13	5

Table 4.5	Frequency of individual scores for technological aspects on quality assurance (Score 0, 1, 2, and 3 represent no, low, medium, and high level; score 4 represent incomplete information)					
Technological aspects	**Indicators**	**Frequency**				
		0	**1**	**2**	**3**	**4**
Farming practices	Identification system	0	1	11	16	5
	Animal health	0	1	11	14	7
Collection stations	Regularly milking	0	0	1	27	5
	Withdrawal period	0	0	6	18	9
	Worker hygiene	0	0	8	21	4
	Milking	0	0	2	24	7
	Chemicals	0	1	4	20	8
	Parlor condition	0	0	15	13	5
	Clean potable water	0	0	6	19	8
	Milking/cooling equipment hygiene	0	0	7	20	6
Distribution	Quality control prior to/during transportation	0	2	10	17	4
	Cleaning procedure	0	1	10	19	3
Milk reception	Inspection	0	0	1	30	2
	Hygiene condition	0	0	6	23	4
	Filtration	0	1	3	25	4
	Storage	0	0	4	27	2
Transformation	Heating time & temperature	0	0	5	21	7
	Cooling pasteurized milk	0	1	1	19	12
	Pasteurization equipment design	0	0	1	26	6
	Equipment cleaning	0	0	3	25	5
	Factory layout	0	0	0	25	8
Retail practices	Traceability	0	1	10	14	8
Final food preparation	Expiration date	0	1	6	23	3

For detailed analysis, the distribution of scores from four subgroups is summarized in Figure 4.2, Figure 4.4, Figure 4.5 and Figure 4.6. These figures have been illustrated through specific indicators that the subgroups are responsible for, the situation of current dairy sector in China was revealed accordingly.

Subgroup 1: researchers from university/research institute

Fig. 4.2 **Frequency of subgroup scores "Researchers from university/research institute" (10 respondents)**



In total 10 researchers from universities/research institute filled in the questionnaire. More uncompleted answers were shown in blue in the above bar chart from indicator B1.2 to B3.2, where represented the pre-farm gate of the dairy chain. Although some of these researchers had positions in local dairy companies as consultants, they had more experience on management and laboratory testing within the companies rather than dairy farming.

This subgroup expressed their concerns on managerial aspects of food safety activities (score 1 in red): Traceability (A1.3), Training (A2.1), Supervision and support schemes (A2.2), and Documentation & record (A3.3). The respondents were not satisfied by the government's performance, especially the governance on traceability system and training.

With regard to high scored indicators, 9 out of 10 respondents gave score 3 on Inspection (B4.1), Pasteurization equipment design (B5.3), and Factory layout (B5.5). High level of validation on inspection reflected the situation that the inspection of raw milk had been strengthened at the reception of dairy companies after the melamine crisis. This was also confirmed by the words of researcher from Inna Mongolia Agricultural University during the in-depth interview. All the indicators from dairy processor (B4.1-B5.5) were scored high, especially "Pasteurization equipment design (B5.3)" and "Factory layout (B5.5)". This is due to the large quantities of capital funds and the support of local policies, which allows dairy processing enterprises to invest in modern equipment and technologies, introduce managerial methods in their daily operations and improve food quality and safety activities. David Oliver (2008) put a premium on Mengniu UHT factory, and said that it is more advanced than any other factories in New Zealand. The well-kept plant and

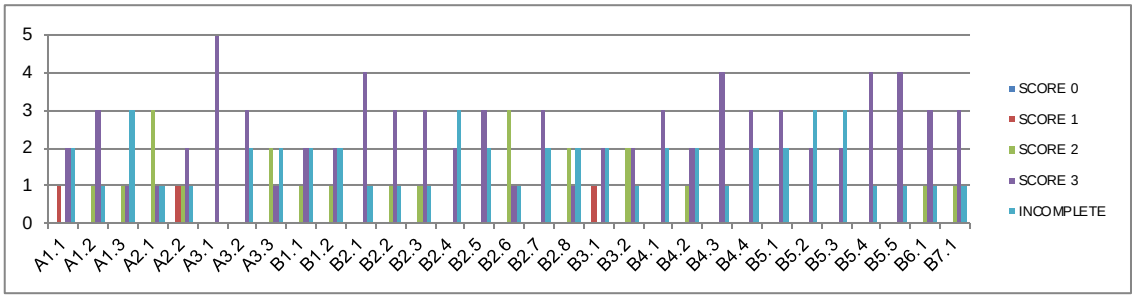
standardized operations can be proven by the author's investigation during the plant tour (Figure 4.3).

Figure 4.3 Infrastructure of highly modern dairy processor.

Four pictures were taken on a Plant tour in Yili Group, named Milking, Storage, Inspection, and Cleaning respectively. November 30, 2011.

Subgroup 2: staff members of government

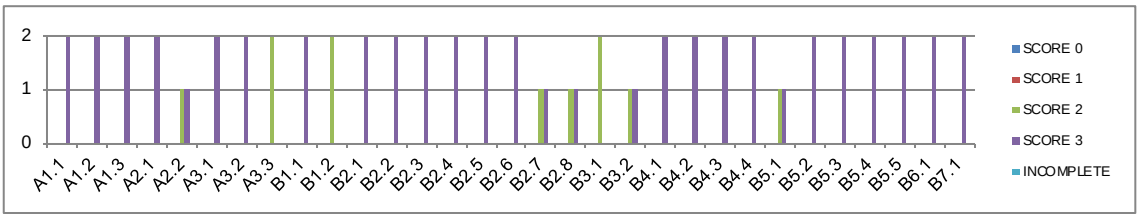
Fig. 4.4 **Frequency of subgroup scores "Staff members of government" (5 respondents)**



Only five valid questionnaires were received from the government. All came from Tianjin Bureau Quality and Technical Supervision. The data frequency from this subgroup gave a view of the actual dairy industry in Tianjin city. It was obvious in this figure that all the five respondents gave score 3 on Supervision and support schemes (A3.1), which means they all thought that the supervision on food quality and safety activities and the support schemes that the government has been performing are already in effect. However, this subgroup contained most uncompleted answers (score 4 in blue). This showed that the respondents were not clear about the validation of specific food safety activities along the entire dairy chain. This figure might give indirect evidence to the absence of national raw milk/dairy processing standards. Both "National Food Safety Standard (2010) – Raw Milk" and "National Food Safety Standard (2010) – Milk Powder" are referring to end-product standards.

Subgroup 3: members of dairy association

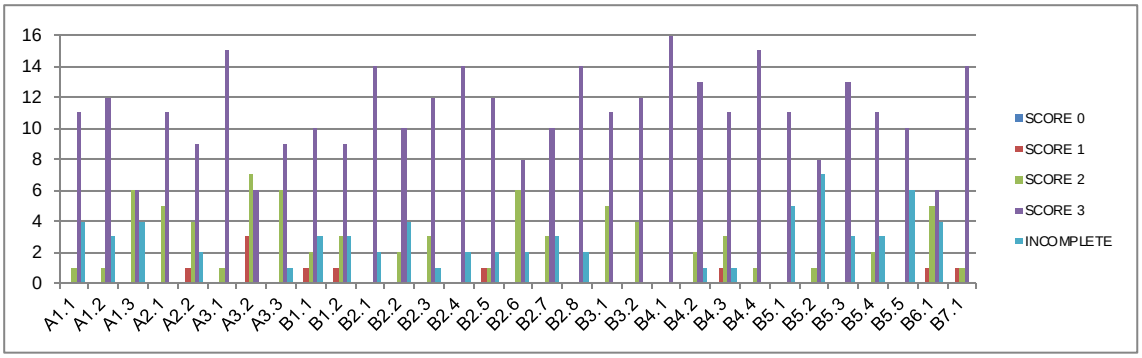
Fig. 4.5 **Frequency of subgroup scores "Members of dairy association" (2 respondents)**



Two respondents from dairy association have noted that they only focused on the one-third of dairy industries with raw milk supply from their own pastoral park. In their opinion, the food safety activities in highly modern industry were performed in advanced level and rarely had food safety problems. However, both of them gave moderate score on Documentation & record (A3.3), Animal health (B1.2), and Quality control prior to/during transportation (B3.1). This might reasonably indicate that falsification of documents is existed in dairy enterprises. The treatments of animal health on farm stage are needed to improve even in dairy companies' own pastoral park. Additionally, transportation of raw milk is a weak point along the dairy chain concerning food quality and safety control.

Subgroup 4: workers from highly modern dairy companies

Fig. 4.6 **Frequency of subgroup scores "Workers from highly modern dairy company" (16 respondents)**



Almost half of the received questionnaires came from workers of dairy companies. All indicators were scored relatively high. This might because the questionnaire was conducted in Top 4 dairy processing enterprises in China. Nevertheless, the problems (Indicator A1.3, A2.1, A2.2, A3.3, B1.2, and B3.1) reflected by the other subgroups were confirmed in this figure by giving medium score (score 2 in green). Apart from this, two more problems were revealed from this figure: Corrective actions (A3.2) and Parlor conditions (B2.6). The workers reported these two problems from their own experience with rejection of proposals and witness of unclean parlor.

It is worthwhile to note that all the respondents gave score 3 to Inspection (B4.1), and 15 out of 16 respondents gave score 3 to Sampling & testing (A3.1) in this subgroup. This proves that the government and dairy enterprises had made radical improvements to the inspection of raw milk after the melamine crisis.

After analyzing the overall picture of the validation of food quality and safety indicators, assigned scores were given. These assigned scores are used to perceive different levels of assessed indicators and to figure out weak points in the dairy chain regarding food quality and safety. Data processing has been performed by using Microsoft Office Excel. According to Sampers et al (2012), for a first and overall impression, overall scores were calculated based on taking all scores of the indicators. The mean scores were overall scores divided by the total number of respective respondents. These mean scores were further transformed into assigned scores following the rules showed in Table 4.6.

Table 4.6	**Rules of assigned score (Food quality and safety performance 1→3: basic to advanced level)**	
Mean score	**Assigned score**	**Level**
0 – 0.2	0	Not present
0.3 – 1.2	1	Basic
1.3 – 1.7	1_2	Lower than moderate
1.8 – 2.2	2	Moderate
2.3 – 2.7	2_3	Higher than moderate
2.8 – 3.0	3	Advanced
Source: Sampers et al., 2012		

An overall picture of the validation of food quality and safety activities in China's dairy chain is illustrated in Table 4.7 and Table 4.8. The 31 indicators were all scored from assigned score 2_3 (39%) to assigned score 3 (61%). Specificity, 5 out of 8 indicators from managerial aspects and 7 out of 23 indicators from technological aspects were performed higher than moderate (assigned score 2_3) but not advanced in food quality and safety.

To answer the sub research question 3, the extent to which China's dairy chain comply with extracted food quality and safety indicators can be summarized as follows: 60 percent of assessed QA activities from the questionnaire were performed in advanced level and the other 40 percent of assessed QA activities were performed in higher than moderate level.

Table 4.7	Assigned scores for managerial indicators			
Managerial aspects	**Indicators**	**Overall score**	**Mean score**	**Assigned score**
Decision-making	Identify critical control points	75	2.8	3
	Validation	82	2.8	3
	Traceability	60	2.4	2_3
Quality behavior	Training	79	2.5	2_3
	Supervision and support schemes	71	2.4	2_3
Auditing and certification	Sampling & laboratory testing	96	2.9	3
	Corrective actions	75	2.4	2_3
	Documentation & record	67	2.4	2_3

Table 4.8	Assigned scores for technological indicators			
Technological aspects	**Indicators**	**Overall score**	**Mean score**	**Assigned score**
Farming practices	Identification system	71	2.5	2_3
	Animal health	65	2.5	2_3
Collection stations	Regularly milking	83	3	3
	Withdrawal period	66	2.8	3
	Worker hygiene	79	2.7	2_3
	Milking	76	2.9	3
	Chemicals	69	2.8	3
	Parlor condition	69	2.5	2_3
	Clean potable water	69	2.8	3
	Milking/cooling equipment hygiene	74	2.7	2_3
Distribution	Quality control prior to/during transportation	73	2.5	2_3
	Cleaning procedure	78	2.6	2_3
Milk reception	Inspection	92	3	3
	Hygiene condition	81	2.8	3
	Filtration	82	2.8	3
	Storage	89	2.9	3
Transformation	Heating time & temperature	73	2.8	3
	Cooling pasteurized milk	90	2.9	3
	Pasteurization equipment design	80	3	3
	Equipment cleaning	81	2.9	3
	Factory layout	75	3	3
Retail practices	Traceability	63	2.5	2_3
Final food preparation	Expiration date	82	2.7	2_3

Indicators with assigned score 2_3 represent lower level of validation of food quality and safety activities. These indicators could be considered as challenges to the upgrade of China's dairy chain. As an answer to sub research question 4, the key challenges to upgrade the quality and safety of China's dairy chain are summarized in Table 4.9.

Table 4.9	Possible challenges to the improvement of China's dairy chain	
Problem aspect	**Area/chain stage**	**Description**
Managerial aspects	Decision-making	Traceability
	Quality behavior	Training
		Supervision and support schemes
	Auditing and certification	Corrective actions
		Documentation & record
Technological aspects	Farmers	Identification system
		Animal health
	Milk collection stations	Worker hygiene
		Parlor condition
		Milking/cooling equipment hygiene
	Distribution	Quality control prior to/during transportation
		Cleaning procedure
	Wholesalers/retailers	Traceability
	Consumers	Expiration date

The potential problems and corresponding solutions for each indicator with assigned score 2_3 were consulted with experts during the in-depth interview.

4.4 In-depth interview

In this section, the analysis of in-depth interview will answer the sub research question 5: *"What policies or strategies are developed to improve the quality and safety of China's dairy chain?"*

The qualitative study which is supported by 6 interviews provided the causes of challenges and corresponding solutions. After the melamine scandal, a great mistrust of dairy products, especially milk powder, by domestic consumers made food safety a very sensitive topic. Under this situation, all the interviewees refused the sound recording. Two of them accepted interviews anonymously. The background of interviewees is shown in Table 4.10. The interview records are translated into English in Appendix 7. Main content of the interviews is summed up and brief analyzed in Appendix 8.

Table 4.10		Interviewee background		
Time	**City**	**Work background**	**Interviewee**	**Number of people**
25/11/2011	Beijing	China Dairy Industry Association	Member	1 (A)
28/11/2011	Hohhot	Inner Mongolia Agricultural University	Researcher	1 (B)
30/11/2011	Hohhot	Yili Group	Inspector/quality controller	2 (C/D)
8/12/2011	Shanghai	Shanghai Dairy Association	Member	1 (E)
12/12/2011	Beijing	MOA – Milk and Dairy Product Inspection Center	Deputy director	1 (F)

Figure 4.7 depicts the variety of sources that derive the indicators in the dairy chain. The indicators with underlines in yellow are the challenges have yet to be addressed. The reasons for the challenges were given during the in-depth interviews. In the rest of this section, the causes of these challenges are individually analyzed according to different indicator sources.

Fig. 4.7 Source of derived indicators and challenges need to be addressed (The indicators with yellow underlines are considered as the challenges)

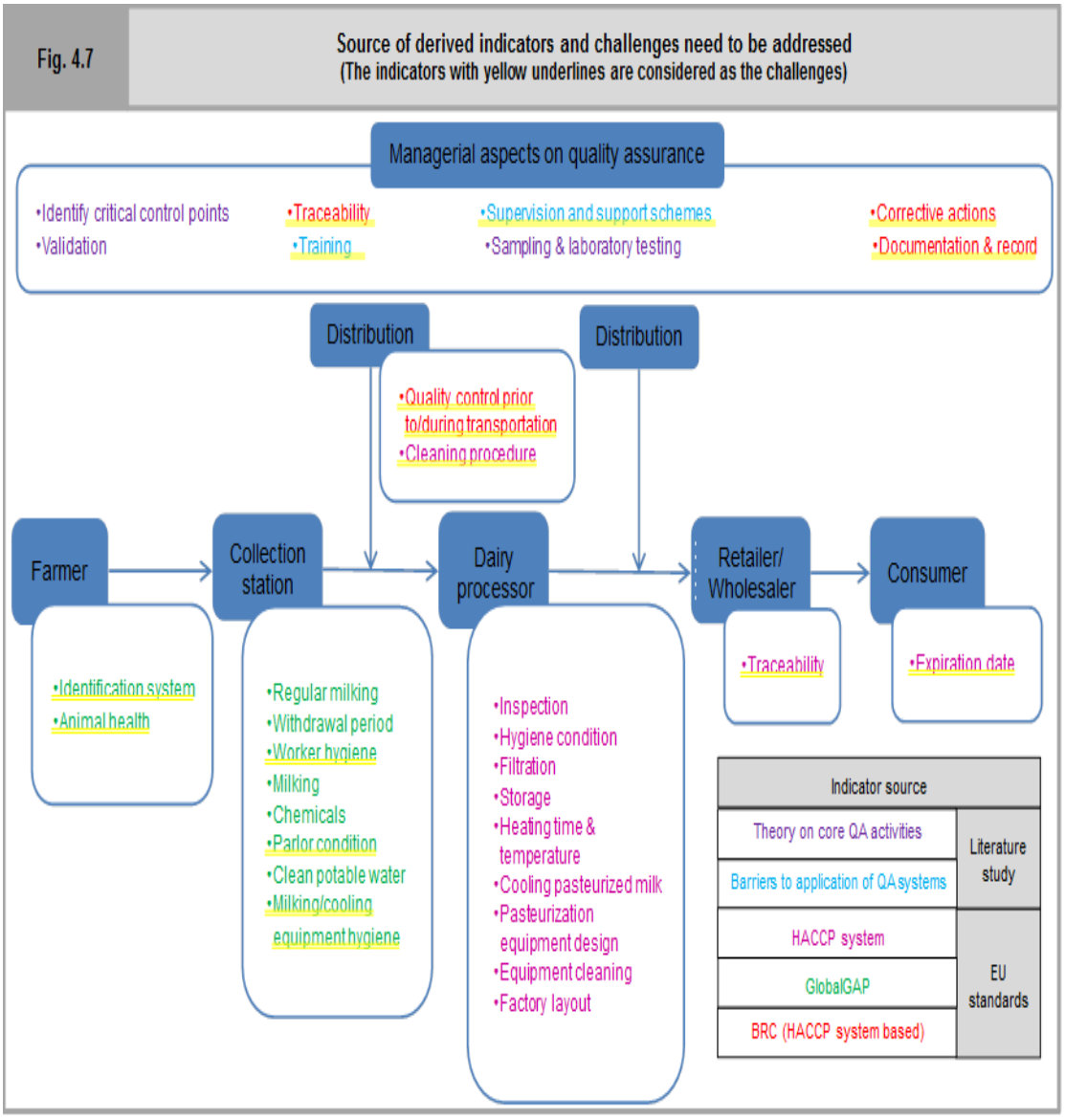
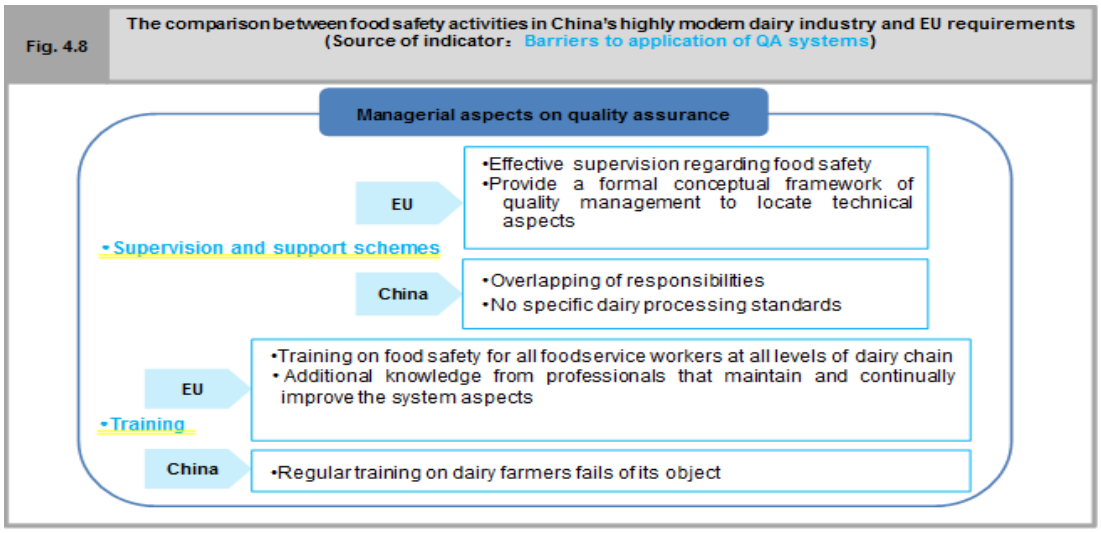


Figure 4.8 shows the challenges source from barriers to application of QA systems. “Supervision and support schemes” and “Training” are two major barriers to the implementation of QA systems based on the literature study. According to the questionnaire, China’s highly modern dairy industry faced the same hurdles as well. For the assurance activity “supervision and support”, the responsibilities from different departments of government were overlapped, which failed the requirement of effective supervision in EU. Also, there were no specific dairy processing standards to provide formal framework of quality management.

> Interviewee A (respondent from Inner Mongolia Agricultural University, who had experience on investigation of dairy farming): ⋯ the responsibilities from different government departments were not clear, and in the end, nobody in the authority was available to take specific responsibility especially for the numerous private milk collection stations.



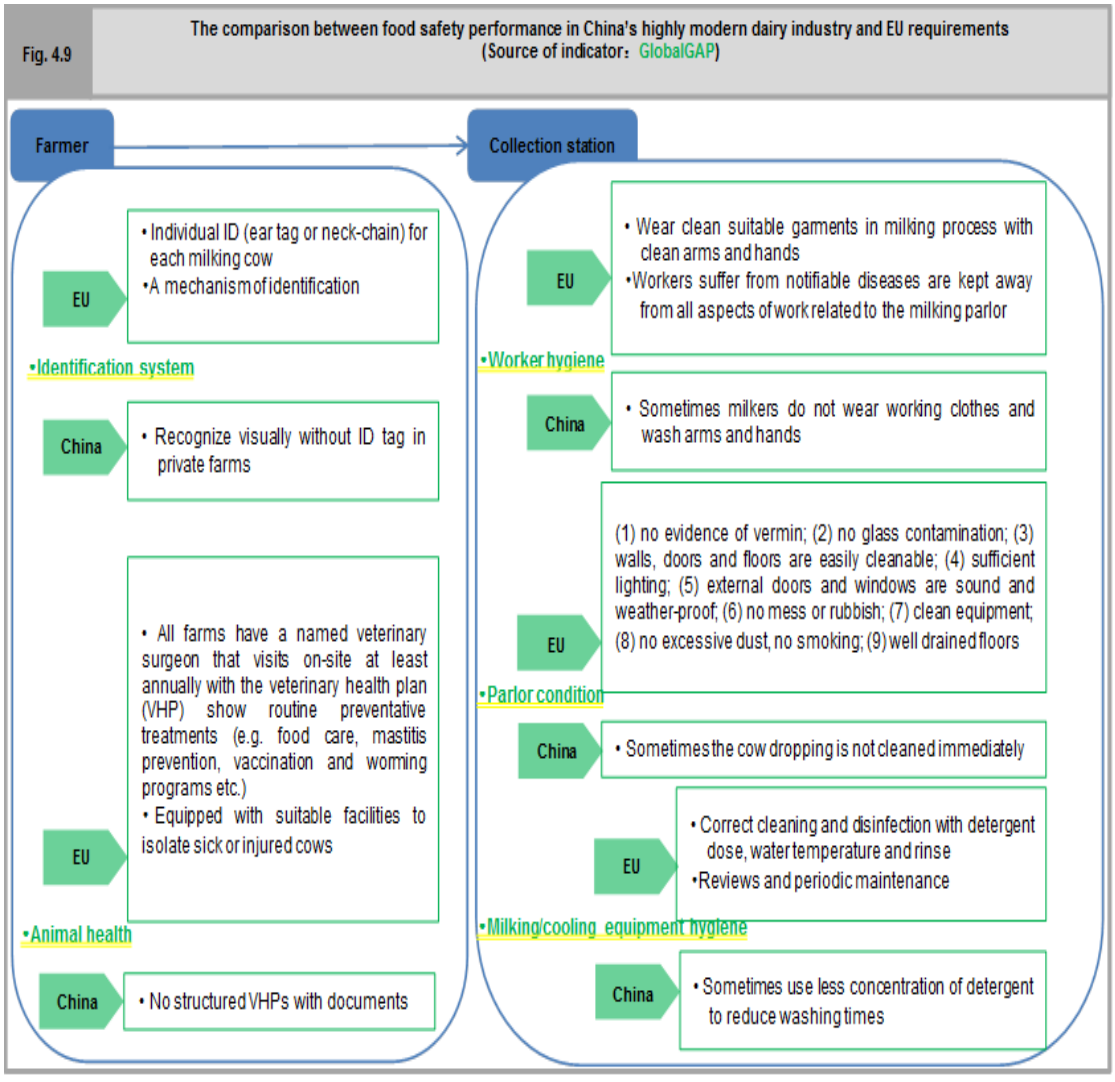
Uneducated dairy farmers were associated with the challenge of “Training”. Even though the government undertook training of dairy farmers regularly, small farmers still had no consciousness to take care of food safety problems. Besides, there was no profit motivation for small farmers to take extra costs on food safety operations.

> Interviewee A: ⋯the farmers may not totally understand what they learned. Also, maybe the training cannot meet the real needs of the farmers. From my experience, they care more about animal health than food safety behavior.
> Interviewee B (respondent from China Dairy Industry Association): ⋯the quality of dairy farmers is a big problem, they are poor and have no education background, they do not necessarily operate according to the training.
> Interviewee C (Quality controller from Yili Group, who was in charge of dairy farming and raw milk quality): ⋯There’s no profit motivation for dairy farmers.

Figure 4.9 gives the reasons that China’s highly modern dairy sector failed to meet certain

GlobalGAP requirements. The problems were happened in farmer and milk collection station stages. In farmer stage, “Identification system” performed well in dairy companies’ own pastoral park. However, in private farms, there was no ID tag because the farmers usually recognized their cows visually.

> Interviewee C: ⋯for some small farms, there was no ID tag because the farmers can recognize their cows visually, or they can paint a sign with color on the tail of the cow.



For the challenge of “Animal health”, all farms could always reach veterinaries for free and necessary preventative treatments were performed. But there was no structured veterinary health plan (VHP). In milk collection station stage, “Worker hygiene” was not on assurance even in dairy companies’ own pastoral park. Sometimes milkers did not wear working clothes or wash arms and hands because they used milking equipment without touching cows’ udder directly (according to the interview with quality controller of Yili Group). The indicator “Parlor condition” didn’t perform in advanced level because sometimes the cow droppings were not removed immediately (according to the interview

with inspector of Yili Group). The demand for “Milking/cooling equipment hygiene” was not satisfied because sometimes less concentration of detergent was used to reduce washing times during cleaning procedure (according to the interview with quality controller of Yili Group).

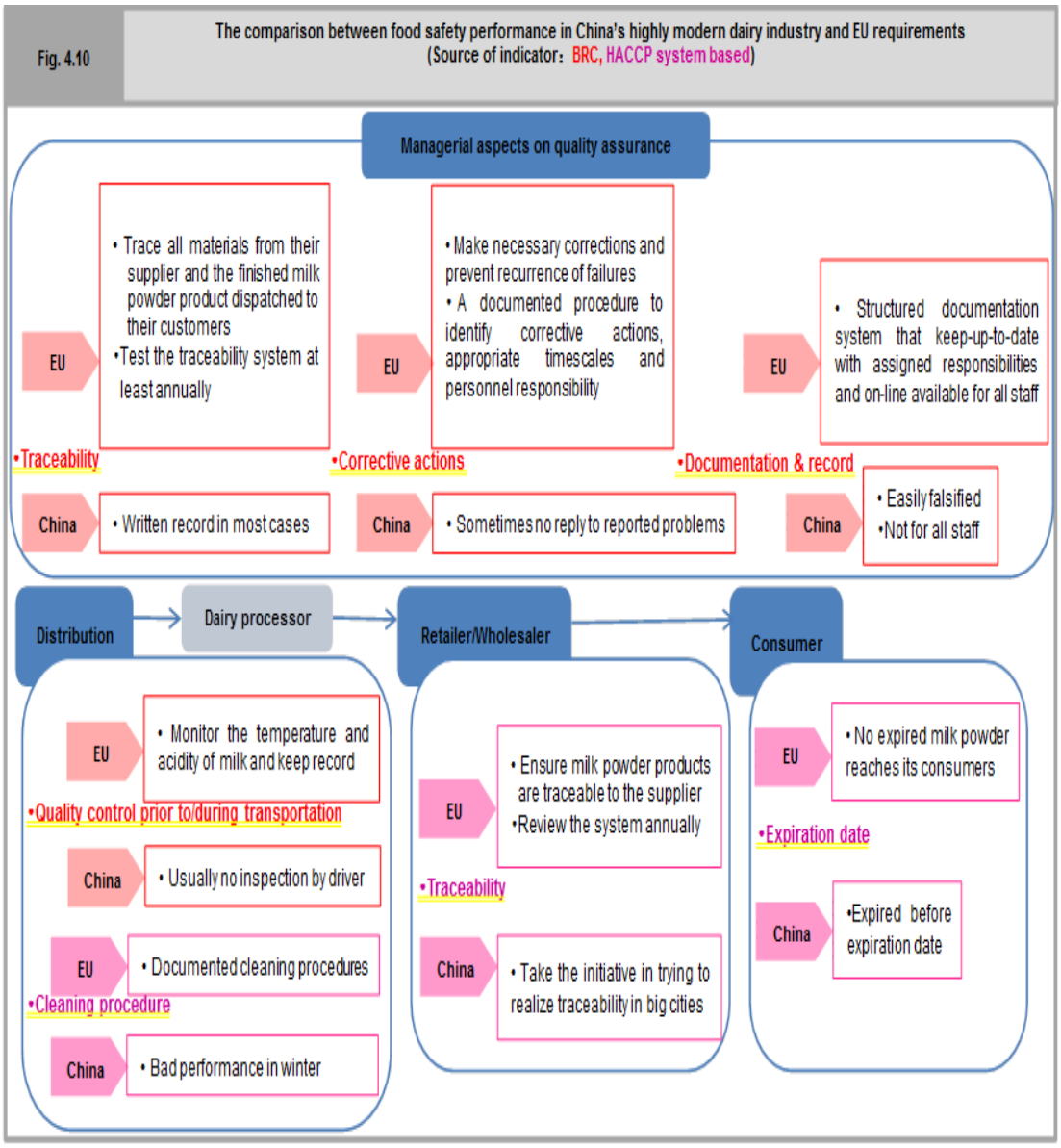


Figure 4.10 pictures how China’s highly modern dairy sector failed to comply with the requirements sourced from BRC (HACCP system based) and HACCP norms. For HACCP system, the uncontrolled critical control points were set in distribution, retailer/wholesaler, and consumer stages. During distribution, “Cleaning procedure” performed bad in winter. The washing water was easy to be frozen in the truck in winter and became difficult to deal with (according to the interview with quality controller of Yili Group). “Traceability system” in retailer/wholesaler stage was poor, big retailers in modern cities took the initiative in trying to realize sound traceability system. In consumer stage, occasionally consumers bought expired products before “Expiration date”. The expert from Shanghai Dairy

Association made a clear explanation of this point. The flavor, state, and bacteria content were changed before the expiration date. One reason could be the poor raw milk quality. Bacteria count 2,000,000/ml (100,000/ml in Europe) required in the "National Food Safety Standard — Raw Milk" cannot guarantee good raw milk quality. Because of the low requirement, even though the modern enterprises had the ability to produce higher quality of raw milk, they were not willing to strive for that because of higher cost. The other reason goes into ultra-high-temperature processing, which is the main sterilization method in China rather than pasteurization. The extreme heat temperature causes significant losses in protein.

Other challenges sourced from BRC rules (exclude HACCP norms) were presented in managerial aspects and distribution stage in the dairy chain. For managerial aspects on quality assurance, "Traceability" was a challenge not only in the retailer stage, in most cases of the entire dairy chain, the purchasing of materials from suppliers was only recorded by hand. For example, the registration of raw milk batches which required samples to individual cows was performed by written record (according to the interview with quality controller of Yili Group). Traceability system came into use by a small number of enterprises in modern cities. On July 5 2011, Meien Dairy Company in Shaanxi took the initiative in implementing traceability system in China with the support from Shaanxi Bureau of Quality and Technical Supervision. Hopefully the success of Meien Dairy Company will accelerate the promotion of traceability system throughout the country (Fineboon, 2011). "Corrective actions" was not of assurance because of the neglects or slow reaction to reported problems by managers of dairy companies.

> Interviewee D (Inspector from Yili Group): …sometimes we report problems to the managers but receive no reply or very late reaction.

The "Documentation and record" was easily falsified by workers who took the responsibility to record. Also, the documents were not available on-line for all staff. Only the people who were authorized had the right to reach them.

> Interviewee B: … documentation and records could be easily falsified. Electronic record will improve this situation to some degree.
> Interviewee D: …workers take the responsibility to record per hour, if they miss out one data, it is possible to falsify because usually the fluctuating range of data is stable. Punishment is necessary in this matter.

For distribution stage, "Quality control prior to/during transportation" cannot be guaranteed. Because in private milk collection stations, the raw milk transportation was usually outsourced to uneducated truck driver. The driver cannot ensure the monitor of temperature and acidity of raw milk. The regular inspection was conducted by dairy processors when the raw milk was sent to the milk reception (according to the interview with quality controller of Yili Group).

After identifying the causes of challenges, the interviewees were asked to propose solutions to upgrade the validation of food safety activities in China's dairy chain. Table 4.11 summarizes the causes of challenges and the accompanying solutions.

Table 4.11	Solutions to upgrade the validation of food safety activities	
Challenges	**Causes**	**Solutions**
Traceability	•A small number of enterprises in modern cities came into use traceability system	•Improve traceability technology
Supervision and support schemes	•Overlapping of responsibilities •No specific dairy processing standards	•Clear-cut responsibilities of different departments of government •Lay down dairy processing standard
Corrective actions	•Neglects or slow reaction to reported problems	•Managers should be able to engage employee involvement •Accomplish electronic record
Documentation & record	• Easily falsified •Not for all staff	
Expiration date	•High bacteria count •UHT method	•Encourage enterprises to reduce bacteria count •Encourage pasteurization method
Animal health	•No structured documental VHPs	•Design VHPs in dairy farms
Worker hygiene (Milk collection station)	•Milkers did not wear working clothes or wash arms and hands	•Establish standards for quality assurance activities with a system of rewards and punishments •Strengthen the supervision and inspection
Parlor condition (Milk collection station)	•Cow dropping was not removed immediately	
Milking/cooling equipment hygiene (Milk collection station)	•Less concentration of detergent was used	
Cleaning procedure (Distribution)	• Bad performance in winter	
Training (Farmer)	•Poor quality of small farmers •No profit motivation	•Vertical integration of dairy supply chain (Figure 4.6)
Identification system (Farmer)	•No ID system in private farms	
Quality control prior to/during transportation (Distribution)	•No inspection by driver	

- Traceability

So far only a small number of dairy enterprises in modern cities took the initiative in trying to use traceability system, the same thing happened for big supermarkets. There are no traceability of raw milk and other materials from suppliers to dairy processors and no traceability of milk power products from processor to supermarket. Their normal practice is to keep electronic/written record. Therefore, to develop and improve traceability technology in quality assurance schemes is necessary. And in the long run, traceability should not be focused on processor and retailer of the dairy chain, integrate traceability in the complete dairy chain should be a general trend towards transparent dairy chains.

- Supervision and support schemes

For the local government departments, to clear-cut responsibilities of different departments could be good for comprehensive supervision and effectiveness. Especially in first part of dairy chain, a large number of milk collection stations could easily result in overlapping of responsibility. Another suggestion to the government is to lay down dairy processing standard. The existing standards only refer to end products, raw milk and milk powder ("National Food Safety Standard – Raw Milk" and "National Food Safety Standard – Milk Powder"). The expert from Shanghai Dairy Association suggested drafting new standard for dairy processing with MOA, but the proposal was rejected because the authorities didn't want to hamper the initiative of dairy processors by processing standard.

- Corrective actions; Documentation & record

A critical solution to these two challenges is to make managers able to engage and sustain employee involvement. Encouraging maximal employee involvement regarding food quality and safety and realizing group problem solving will improve the performance of corrective actions. Sharing documents with staff on-line could encourage employee involvement and arouse employee awareness of QA principles. In addition, to replace written record with electronic record will prevent falsification and make transparent work environment so as to improve employee involvement and work efficiency.

- Expiration date

To ensure the product quality, the quality of raw milk is a prerequisite. The old raw milk standard (which was promulgated in 1986) set four levels of bacteria count, 500,000/ml, 1,000,000/ml, 2,000,000/ml, and 4,000,000/ml. while the new raw milk standard became effective in 2010 provided legal limit bacteria count of 2,000,000/ml. The statement is saying that the new limit will stabilize raw milk supply and protect small dairy farmers. In fact, the demand of bacteria count was lower than 300,000/ml in modern cities like Shanghai (investigated by expert from Shanghai Dairy Association). But the new raw milk standard cannot urge dairy enterprises to strive for higher raw milk quality. The solution is to encourage dairy enterprises to formulate their own private raw milk standards with low limit on bacteria count. Moreover, to encourage pasteurization rather than UHT method during sterilization will limit the protein losses caused by extreme high temperature. The pasteurization method also requires high raw milk quality.

- Animal health

The structured VHPs should be developed by the veterinary surgeon of the farms and the in-house health personnel in the maintenance of health in dairy cows. VHP is now a requirement of many quality assurance schemes.

- Worker hygiene; Parlor condition; Milking/cooling equipment hygiene; Cleaning procedure (distribution)

All these challenges were related to milk collection station. The raw milk transportation was usually outsourced by milk collection station. On one hand, the owner of the milk

collection station could set rules on quality assurance activities with a system of rewards and punishments. On the other hand, the government should strengthen the supervision and inspection of assurance activities on milk collection stations.

- Training; Identification system; Quality control prior to/during transportation

Based on the investigation, there was no identification system in small private farms and the training on small farmers or drivers did not really work. The ideal solution is to realize vertical integration of dairy supply chain although it is impossible to implement in the short run. Two courses of action will make sense in the chain integration (see Fig. 4.11) according to the consultations with the researcher from Inner Mongolia Agricultural University and the member from Shanghai Dairy Association.

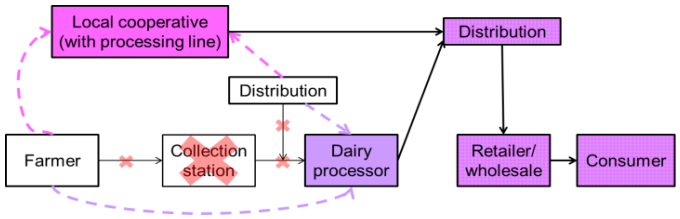


Figure 4.11 Vertical integration of dairy supply chain

- Abolishing milk collection stations, farmers and drivers invest their dairy cows and trucks and become a shareholder of dairy processors. They have the rights to share out a year-end bonus. The dairy processors provide personnel support to ensure food safety. The "Community Interest" could make farmers and drivers have willingness and responsibilities to participate in improving food quality and safety performance.
- However, there are too many farmers but relatively fewer dairy processors. To safeguard the benefit of small farmers, local cooperative is another option. The government should encourage big farmers to manage local cooperative and establish their own dairy processing line. Small farmers and drivers invest their dairy cows and trucks and become a shareholder of local cooperative. They could also have the rights to share out a year-end bonus. The government provides personnel and technical support to ensure food safety.

The in-depth interview also referred to the reason that the EU banned Chinese milk products since 2002: *"The import in the EU of milk products from China has been prohibited under EU legislation since January 2002, saying that the Chinese residue pesticide system did not reach standards set down by the EU, to what degree do you think the residue pesticide system has been improved?"*

According to the expert from China Dairy Industry Association, the residue pesticide system did not making much progress. There were still significant gaps in the number of testing items and maximum residue limit (MRL) between China and the EU. Figure 4.12 shows a comparison of testing items (the number of tests by public authorities) of pesticide residue between different regions in the world. There are far fewer testing items formulated by the authorities in China than the number of pesticides used in agricultural industry due to the lack of analyzing technology and testing equipment. But in modern cities like Shanghai, the independent laboratories have enough technical supports to test

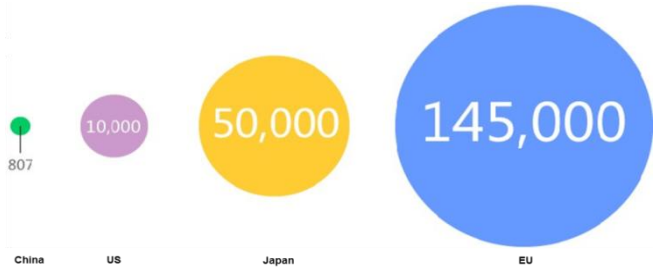


Figure 4.12 The comparison of testing items of pesticide residue between different regions in the world

extra items required by developed countries (http://www.zgny.com.cn/ifm/consultation/2006-5-29/98494.shtml). The Deputy Director from "Institute for the Control of Agrochemicals, Ministry of Agriculture" stated that the pesticide residue standard is going to be up to 7,000 items within 3 years (http://discover.news.163.com/special/pesticideresidue/). But there still exist a big difference between that and the 145,000 testing items in the EU. The upgrade of pesticide residue standard allows no delay. Otherwise the barrier would still impact on oversea export of dairy products seriously.

As shown in the above figure, the number of pesticides tested in the USA is very low while compared that with Japan and the EU. Europe has much more strict pesticide residue level allowance when compared to North America. This is because European regulators acknowledge the potential health risks posed by these residues (http://www.naturopathiccentre.com/styled-7/styled-69/). An international comparison of pesticide regulations was conducted between Canada, the US, the EU, and Australia (David Suzuki Foundation, 2006). This international assessment compared MRLs for 40 pesticides and revealed that the EU clearly had the strictest standards (the lowest MRL) for 29 pesticides, while the US had the weakest MRL for 21 of the examined pesticides. From this it can be inferred that the export of farm produce to the US would be easier than the export to the EU.

The two national food safety standards involved in this study, Raw Milk and Milk Powder, displayed the fact that the quality control system in China's dairy sector is still focused on end-product testing rather than the quality assurance systems applied in the EU. The change strategy of implementing QA systems in China's dairy sector was discussed during the interviews (see Appendix 7). Shared power strategy is quite time-consuming, so a force-coercion strategy that uses rewards and punishments as primary inducements to change is suggested. Although with little commitment, the outcomes are overweigh the drawbacks. Meanwhile, a combination of force-coercion strategy and rational persuasion strategy which backed by expert power would help longer lasting and internalized change. For auditing of China's dairy sector, to strengthen internal audit carried out by the organizations themselves is necessary. The poor performance of "Corrective actions" and other low scored indicators from the stages of farms, milk collection stations, distributions and dairy companies based on the survey revealed the ineffective internal audits.

The barriers to the implementation of QA systems such as cost, sufficient time, and tailor EU assurance activities for specific characteristics of China's dairy chain were consulted with experts (see Appendix 7). All these barriers are currently faced by China's dairy

industry. Moreover, these barriers are resistant to change and hard to minimize in a short run.

4.5 Data triangulation

This section elaborates on the mutual relations between the survey and interviews. There are three relations linking the survey and the interviews:

Relation 1: the interviews confirm high validation of indicators in the survey

Indicator "Sampling & Laboratory testing" and "Inspection" are typical examples of this relation. Totally 30 respondents gave score 3 to these two indicators. This represented that structured sampling with fixed frequency was performed in China's dairy sector to confirm food quality and safety. The high level of validation was supported by the interviews. During the interviews, both the researcher from Inna Mongolia Agricultural University and the member from China Dairy Association emphasized that the frequency of sampling and inspection have been greatly increased after melamine crisis.

Besides, more than 25 respondents scored 3 for "Storage", "Equipment cleaning", and "Factory layout". The high level of validation on these three indicators can be confirmed by the researcher's plant tour. As the photos shown in Figure 4.6, the condition of storage, equipment cleaning and the factory design were performed well.

Relation 2: the interviews confirm low validation of indicators in the survey

Typical examples of this relation are from managerial aspects: "Training", "Corrective actions" and "Documentation & record". Approximately half of the total respondents scored 1 or 2 to these three indicators. The poor performance of training was verified by the statements of the researcher from Inna Mongolia Agricultural University, the member from China Dairy Association, and the quality controller from Yili Group (see appendix 7). During the on-site questionnaires in dairy companies, the researcher was informed that most of the workers were not satisfied with the performance of corrective actions. This is because their managers didn't put much value on what they reported. The falsification of records was also confirmed by the interviews with the member from China Dairy Association and the inspector from Yili Group.

Examples from technological aspects could be "Identification system", "Animal health", "Parlor condition", "Quality control prior to/during transportation" and "Cleaning procedure (distribution)". Approximately half of the total respondents scored 1 or 2 to these indicators. The interviews and on-site questionnaires with workers from dairy companies confirmed the poor performance. The following citations of the interviews would reflect the low level of validations of these indicators:

Interviewee C: …for some small farms, there's no ID tag because the farmers

can recognize their cows visually …no structured VHPs … the milk collection station outsourcing raw milk transportation to uneducated truck driver, I'm afraid there's no quality control on the raw milk during transportation. But regular inspection is conducted by the reception of dairy companies … cleaning of truck performed very well in summer, but not very well in winter because the washing water is easy to be frozen and hard to deal with in the truck.
Interviewee D: …sometimes the cow dropping is not cleaned immediately in the parlor.

Relation 3: the interviews are contradictory to the validation of indicators in the survey

In this relation, specific indicators were obtained relatively high level of validation in the survey. However, the interviews revealed that the high level of validations is not true in fact. Examples from managerial aspects are "Identify critical control points" and "Traceability". There were 22 respondents scored 3 to "Identify critical control points". However, during the in-depth interview with the quality controller of Yili Group, it is known that the workers usually control CCPs based on their own experience rather than a HACCP plan which formulated by a HACCP team. With regard to "Traceability", there were 2 respondents scored 1, 11 respondents scored 2, and 12 respondents scored 3. This means 12 respondents perceived that the traceability system was performed in advanced level in China's dairy chain. This caused suspicion because several big dairy enterprises and retailers had just taken the initiative in implementing traceability system. High scores might due to the misunderstanding of traceability system. For example, the quality controller from Yili Group gave score 3 to "Traceability", saying that "…on farm stage, the raw milk sample from each dairy cow is preserved before mixing. Tracing back to specific cow is not a problem". Nevertheless, what he said was not a implementation of traceability system.

Another example from technological aspects is "Expiration date". In total 23 respondents scored 3 to this indicator. However, a few respondents had experienced that the products were expired before the expiration date. This experience is not accidental according to the member from Shanghai Dairy Association. The poor raw milk quality and the treatment of high temperature contributed to this. It is more common for dairy products like liquid milk and yogurt.

The next chapter discusses the results and findings from the empirical research. Theoretical contributions and limitations of this study are elaborated.

5. Conclusions and discussion

This chapter discusses the findings of the empirical research. Section 5.1 answers all the research questions. Section 5.2 elaborates theoretical contributions of this study. Section 5.3 enumerates limitations of this research and suggestions for further study. Section 5.4 presents general conclusions.

5.1 Research questions

This research aims at evaluating the extent to which Chinese dairy products are able to comply with EU standards for food quality and safety along the entire dairy chain. To accomplish that survey and interviews are carried out. With these methods, key challenges and accompanying solutions to upgrade quality and safety of China's dairy chain are investigated.

The investigation starts with literature review on theories and relevant information. Based on China-EU dairy trade (section 2.3), the target dairy product for the assessment of food quality and safety activities is chosen to give an answer to the first sub question: *Which representative dairy product is selected from a broad range of dairy products to conduct an in-depth investigation based on the past China-EU dairy trade record?* The whole milk powder is selected among the numerous dairy products because of its nutrition value, widespread application, export motivation, coverage of entire dairy supply chain, and the chance to lift the ban according to the past China-EU dairy trade.

To understand QA requirements, especially the HACCP, GlobalGAP, and BRC norms, indicators are developed into an evaluation framework (section 2.7). This answers the second sub question: *What is an evaluation framework with indicators to assess food quality and safety performance of entire China's dairy chain?* The evaluation framework as shown in Figure 2.8 contains 13 areas and 83 indicators along the dairy supply chain toward both managerial and technological aspects. To answer second sub question a: *What are the indicators extracted from quality assurance (QA) concepts?* A study of theories on QA concepts is presented in section 2.4. To answer second sub question b: *What are the indicators extracted from QA public and private standards in the EU?* Typical public and private QA standards are learned (section 2.5). To answer second sub question c: *What are the indicators extracted from the implementation of QA standards in different regions of the world?* A literature study on the adoption of QA systems in food industry is done (section 2.6).

After reviewing theories, the way of assessing food quality and safety activities is built in methodology (chapter 3). The evaluation questionnaire consists in two aspects: managerial aspects and technological aspects. In section 4.3, the third sub question: *To what extent does China's dairy chain comply with extracted food quality and safety indicators?* is answered according to the questionnaire analysis. For highly modern dairy

industry, 60 percent of assessed QA activities from the questionnaire were performed in advanced level and the other 40 percent of assessed QA activities were performed in higher than moderate level. The investigation of other dairy industries is not included in this research.

As result, the lower scored indicators from the questionnaire constitute the challenges faced in China's dairy chain, which answers the fourth sub question: *What are the key challenges to upgrade the quality and safety of China's dairy chain?* Approximately half of the assessed indicators have space to improve. In managerial aspects, the traceability system needs to be implemented in dairy industry; training is hard to achieve desired effect; the government is asked to clear-cut the responsibilities of supervision; corrective actions and documentation need to be noted. In technological aspects, pre-farm gate work needs to be improved, e.g. identification system and animal health in dairy farms; worker hygiene, parlor condition, and equipment hygiene in milk collection stations. At the linkage of dairy chain, food quality and safety activities can be seen as challenges during transportation, e.g. quality control and cleaning procedure. Moreover, traceability in retailer stage also needs to improve. Expiration date exposes the challenge to upgrade raw milk quality.

To explore the causes of above challenges and the accompanying solutions, in-depth interviews are carried out. In accordance with the interviews and subsequent analysis (section 4.4) it is possible to answer the fifth sub question: *What policies or strategies are developed to improve the quality and safety of China's dairy chain?* In view of existing challenges, corresponding strategies are elaborated in Table 4.11. The technology of traceability needs to be applied and improved; to clear-cut responsibilities and lay down dairy processing standards are expected to the government; the quality managers should be able to engage employee involvement and accomplish electronic record; the dairy enterprises should be encouraged to set their own standards on bacteria count and sterilization method to improve raw milk quality; structured VHPs should be designed in dairy farms; the supervision and inspection of assurance activities on private milk collection stations should be strengthened; and a formulation of long-term plans on dairy chain integration is good to the development of China's dairy chain.

After the elaboration of sub research questions, the central research question can be answered: *To what extent do Chinese dairy products comply with quality and safety standards of EU and how can the quality and safety of dairy chain be upgraded so that Chinese dairy producers will be able to produce according to these standards?*

Around 60 percent of the essential food quality and safety activities assessed in this research were performed in advanced level in China's highly modern dairy industry. While the other 40 percent of essential food quality and safety activities still had space to improve. Furthermore, China's modern dairy industry has both the abilities and disabilities to upgrade its QA activities so as to produce according to EU requirements.

First, China's dairy industry has the abilities to produce according to EU standards based on the following reasons:

(1) The ability to acquire technology and farm assurance schemes

- Big dairy enterprises and supermarkets in China have taken the initiative in implementing traceability system with the support of local authorities.
- Big dairy enterprises have the willingness to develop Veterinary Health Plans in their pastoral park to ensure animal health.

(2) The ability to improve internal audits.

- The government has long been involved in organizing small farmers and small milk collection stations to collective farms to make them manageable.
- Force-coercion strategy can be used in dairy enterprises to engage employee involvement. Quick reaction to corrective reports and accurate record will be ensured.
- Force-coercion strategy can be used in milk collection stations by establishing rules of QA activities, such as worker hygiene, parlor condition, and quality control during transportation.

(3) The ability to improve raw milk quality by individual dairy enterprises.

- Although the new raw milk standard aroused much controversy on the low level of bacteria count, big dairy enterprises have their own private internal standards on bacteria count (usually 500,000/ml, Shanghai dairy industry could reach 300,000/ml).

Second, China's dairy industry also has disabilities in the short term to produce according to EU standards consisted of two situations:

(1) The disability to lay down national dairy processing standard.

- The expert from Shanghai Dairy Association suggested to MOA that dairy processing standards should be drafted. But his proposal was rejected because the authorities don't want to hamper the initiative of dairy processors by laying down standard. And based on the interview with deputy director of Milk Inspection Centre, he insisted that there are enough standards refer to pesticide residue, animal feed, aflatoxin, etc. Therefore, it seems impossible to formulate new national dairy processing standard in the short term.

(2) The disability to realize vertical integration of dairy supply chain.

- The abolishment of milk collection stations and total integration of dairy supply chain are impossible of achievement in the short run. This is also confirmed by the deputy director of Milk Inspection Centre during the interview.

The answers to the research questions lead to a better understanding of food quality and safety of China's dairy sector. It is helpful to improve current food quality and safety activities based on the answers.

5.2 Study evaluation

This study provides important theoretical contributions to the food quality (safety) management literature. Luning and Marcelis introduced a techno-managerial research approach to food quality management in 2002. This approach presents both technological and managerial principles and practices for achieving QA in food industry. Theoretically based on the QA concepts from food quality (safety) management, this study develops an evaluation framework (see Figure 2.8). It integrated the most important norms of QA standards (HACCP, GlobalGAP, and BRC) and the barriers that prevent compliance with QA standards. The evaluation framework contains 13 areas and 83 indicators, which is helpful to a comprehensive evaluation of food quality and safety activities of dairy supply chain. Due to the limitation of this research, only 31 indicators that relate directly to food safety are selected and assessed in China's dairy chain. However, the evaluation framework may be used for future studies. Another important theoretical contribution of this research is that it provides QA requirements for producers that are specific to the dairy sector. The present study thus enlarges the body of knowledge on QA governance in dairy sector.

5.3 Limitations

Some limitations of the study have to be taken into account and are enumerated in the present section:

- The response percentage in this study is 66% although reminder letter was used to increase the response rate. The respondents who occupied a post in the government or dairy companies are trying to avoid the subject. This is because the survey was conducted in a sensitive period after the melamine crisis in 2008 – The requirement of bacteria count (2,000,000/ml) by the new Food Safety Standard (2010) has made controversial comments. The respondents are afraid to give comments which might cause widespread discontent.

Whenever feasible, further survey in dairy sector should get support from the government. Other methods like the use of monetary incentive might also assist in increasing response percentages.

- The method of this study is using four levels of validation in assessing assurance activities. This is based on the previous research conducted by Luning et al. The four levels represent not applied (score 0), low (score 1), medium (score 2), and high (score 3) levels of validation. According to the frequency of scores, high level of validation (score 3) in China's highly modern dairy sector accounted for 74% of the total scores. With the same methodology (but different indicators), the previous questionnaire was conducted in 13 Japanese milk processing plants by Sampers et al (2012). The advanced level (score 3) accounted for 72% of the total scores in that research. It is doubtful if the given scores in this study reflected the real situation of

China's dairy sector, because Japan has a more comprehensive assurance system than China for food manufacturing companies. Also, the melamine crisis in 2008 exposed serious food safety problems in China.

The respondents might not fully understand the definition of the four levels. Another possibility is that the respondents considered the validation of QA activities beyond the medium level and below the high level, but there is no option between these two levels. This suggests that future survey on the validation of QA activities can use a 5-point Likert-type scale.

- The 34 respondents participated in this survey were contacted in advance to ensure they have an overview of the entire dairy chain. However, still not all the respondents have a complete and adequate perspective on all the indicators involved in the questionnaire, which led to the incomplete answer.

The survey can be divided into 5 blocks according to each stage of the dairy chain, and then find respondents who are responsible on specific stages. It would have been preferable to give more validity to the results if the questionnaires and interviews were held with on-site stakeholders.

- There should have some differences between the dairy sectors in China and the EU. The questionnaire might not cover the main food quality and safety activities along the entire dairy chain in China. For instance, the requirements on the method of sterilization in the questionnaire only relate to pasteurization, whereas UHT is more popular in Chinese dairy industry.

There might have more QA indicators derived from Chinese practices that are not included in this study. Therefore the thoroughness of these results can be improved.

- Some respondents made wrong assumption in individual indicators of the questionnaire. The validation of each indicator is time-consuming, but most of the respondents did not take their time and think carefully. This led to misunderstand of the requirements and gave inaccurate scores.

Usually the respondents do not have patients on such complex questions. This suggests that further survey may require on-site instructions with personal explanations to improve the quality of results.

- The survey only refers to highly modern dairy industry located in Hohhot, Beijing, Tianjin, and Shanghai, where have better food quality and safety performance along the entire chain. The validation of food quality and safety activities in other districts is not clear.

Considering the possibility of exportation, this research is only focused on the "District

around modern cities" and "Northeast & Inner Mongolia district". The results cannot represent the average level of validation in China's dairy chain. The assessment of the other three districts needs further investigation.

5.4 Concluding remarks

The objectives of this research are: (1) to evaluate the extent to which Chinese dairy products are able to comply with stringent standards of EU for food quality and safety concerning the whole dairy chain; and (2) to analyze the key challenges to upgrade quality and safety of China's dairy chain and develop recommendations to facilitate China-EU dairy trade.

The present study demonstrates the diversity of dairy districts in China. Two districts regarding four cities (Hohhot, Beijing, Tianjin, and Shanghai) are identified in this investigation. The food quality and safety evaluation framework, based on 83 indicators and 13 areas, can be a useful tool to evaluate the implementation of QA activities. Indicators of this framework are derived from typical QA standards (HACCP, GlobalGAP, and BRC), QA concepts and QA applications. A total of 31 indicators covering 10 areas are developed as benchmark, against which food quality and safety activities in China's dairy chain can be assessed.

A combination of quantitative and qualitative methods was used in this study so that topics could be discussed more completely and in greater depth. The survey analysis revealed that 60 percent of assessed QA activities from the questionnaire were performed in advanced level and the other 40 percent of assessed QA activities were performed in higher than moderate level. Lower scores for assurance activities as "Traceability", "Training", "Supervision and support schemes", "Corrective actions", "Documentation & record", "Identification system", "Animal health", "Worker hygiene", "Parlor condition", "Milking/cooling equipment hygiene", "Milking/cooling equipment hygiene", "Quality control prior to/during transportation", "Cleaning procedure", "Expiration date", indicated a possible source of challenges of food safety problems that China's dairy industry do not yet tailor these activities well. However, it is noted that the target dairy industry in this results only refers to highly modern dairy industry in China.

Qualitative method is used to generate the causes and solutions of the low scored indicators. It enables inclusion of individual experience, which cannot be obtained by a survey or literature research. Some interesting findings are made when comparing the results of the survey and interviews. E.g. the survey indicated "Identification critical control points" a rather high level of performance, which could not be confirmed by the interviews. The interview analysis pointed out some contradictions.

In general of this research, modern dairy enterprises construct pastoral parks near processing plants to ensure advanced quality and safety along the whole dairy chain. Because the raw milk supply from enterprises' pastoral parks could only accomplish

one-third of their manufacturing capability, more than two-third of raw milk supply come from private milk collection stations, at which the assurance activities could not guaranteed. For the other firms that sourced all their raw milk from private milk collection stations, the validation of QA activities could be another important area for further research. A lower level of validation on these assurance activities appears counterintuitive.

Next chapter gives recommendations for different stakeholders to help China's dairy chain improve its food quality and safety.

6. Recommendations

This chapter wants to make a contribution to fully comply with QA standards of the EU and facilitate China-EU dairy trade. Short-term and long-term recommendations are made for the upgrade of China's dairy chain regarding food quality and safety. The following recommendations could be taking into account:

Short-term recommendations

- Dairy enterprises
  - Improve traceability of raw milk and other materials from suppliers.
  - Engage employee involvement by paying attention to corrective reports and sharing documentations.
  - Replace written records with electronic records to prevent falsification.
  - Formulate private standards on low bacteria count and high protein content to strive for higher raw milk quality.
- Supermarkets
  - Improve traceability of milk powder products from processor to supermarkets.
- Governments
  - Clear-cut responsibilities of different government departments, especially in the front stages of the dairy chain.
  - Develop and encourage structured Veterinary Health Plan to assure health in dairy cows.
  - Strengthen supervision on quality assurance activities in milk collection stations.
- Milk collection stations
  - Set rules of quality assurance activities with a system of rewards and punishments by the owner of private milk collection stations.

From the researcher's perspective, the short-term recommendations are likely to be implemented. The dairy enterprises and supermarkets have already paid highly attention to the improvement of traceability. With regard to and the organization of milk collection stations, the government has long been involved in organizing small farmers and small milk collection stations to make them manageable. The rest of short-term recommendations also have the possibilities to be implemented if change strategies are used – Force-coercion strategy and rational persuasion strategy.

Long-term recommendations

- Dairy enterprises
  - Integrate traceability in the complete dairy chains and accomplish transparent dairy chains.
- Governments
  - Although the authorities rejected the proposal of drafting new standards for

specific dairy processing, it is quite necessary to guarantee food safety and promote supervision effectiveness.

- Upgrade pesticide residue standards to bridge the gap of testing items and maximum residue limits between China and the EU.

- Dairy chain integration
  - Abolish milk collection stations. Farmers and drivers invest their dairy cows and trucks and become a shareholder of dairy processors. The dairy processors provide personnel support to ensure food safety. The “Community Interest” makes farmers and drivers have willingness and responsibilities to participate in improving food quality and safety.
  - Develop local cooperative. Big farmers manage local cooperative and establish their own dairy processing line supported by government policies. Small farmers and drivers invest their dairy cows and trucks and become a shareholder of local cooperative. The government provides personnel and technical support to ensure food safety.

Even though the long-term recommendations are impossible to be achieved in the present, they are going to be a trend of development of China’s dairy industry.

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Appendices

Appendix 1

App.1	Derived Indicators from Main Concepts of QA Systems
Managerial aspects on quality assurance	
★ Organizational change conditions	
☆ Management needs to deal with the resistance to change when implementing or improving the QA systems in China's dairy chain. Change strategy for each actor in the chain can be chosen from force-coercion, rational persuasion and shared power.	
★ Decision-making on QA	
☆ Identifying where in the process are critical for quality and safety at each stage of the dairy chain. ☆ Assessing and validating the capability of processes and equipment related to critical points and the control of monitoring systems at each stage. ☆ Assembling project team to comply human behavior to the requirements on critical quality and safety points. ☆ Responsibilities in quality systems of each stage could be shown by the organizational position of the quality department. ☆ Developing rules and procedures for auditing purpose at each stage of dairy chain.	
★ Quality behavior	
☆ Disposition to quality: Actors in the dairy chain must be aware of the quality assurance standards. ☆ Ability to quality: Actors in the chain must have the skills to achieve the quality assurance standards.	
★ Auditing and certification	
☆ Internal audit: Each stage needs to establish a procedure and criteria to determine whether quality activities comply with quality assurance standards. ☆ External audit: Inspections according to certain quality assurance standards with accompanying certification by a third-party are demanded if the dairy products are planned to export to the EU.	
Technological aspects on quality assurance	
★ Farming practices	
☆ Breeds: Cow breeds have a significant influence on quality attributes of raw milk. ☆ Feeding: Amount and composition of feed as well as environmental contaminants and pathogens can affect the quality and safety of raw milk. ☆ Housing conditions: Control the hygienic conditions and movement circumstances for cows to prevent bacterial contamination. ☆ Animal health: Diseases like mastitis lead to alterations in the composition and properties in milk (Auldist and Hubble, 1998); drug residues in milk are assumed to be hazardous for human health.	
★ Collection stations	
☆ Transport: The transport of cows to the milk collection stations refers to the animal welfare aspect. Too much exercise, fear, and fluctuations in hot and cold temperatures are factors that cause stress in animals (Luning and Marcelis, 2009). ☆ Hygiene conditions: Preventive hygienic measures like cleaning of teats, cleaning and sterilizing of milk equipment, and prevent bacterial contamination of milk (Schreiner and Ruegg, 2003; Luning and	

Marcelis, 2009).
★ Distribution & storage of raw milk
☆ Hygiene conditions: Cleaning and sterilizing the tanks and the trucks. ☆ Controlling temperature and relative humidity conditions.
★ Preparation of raw milk
☆ Milk reception: Inspections according to regulations. ☆ Removal of physical agents: Equipment hygiene. ☆ Quality behavior of handlers: Personal hygiene, accurate working.
★ Transformation
☆ Equipment conditions for processes, such as standardization, cooling, pasteurization, vacuum concentration, spray drying and sterilization. ☆ Controlling the microbiology in the line environment. ☆ Controlling the temperature and heating time in pasteurization. ☆ Checking recontamination of milk powder.
★ Packaging
☆ Packaging integrity ☆ Appropriate packaging materials ☆ Proper labeling
★ Storage & distribution of milk powder
☆ Controlling temperature, duration and relative humidity. ☆ Preventing poor handling like broken packages, cross contamination due to mixed product storage.
★ Retail practices
☆ Checking the storage conditions in the shop ☆ Hygienic handling of personal ☆ Packaging integrity
★ Final food consumption
☆ Conditions of domestic storage equipment ☆ Hygienic circumstances at food preparation ☆ Cooking condition

Appendix 2

App. 2	Steps and Principles of HACCP System on Dairy Farm
The twelve steps in the application of HACCP including the seven principles adapted to the on-farm study	
Step 1 Assemble a multidisciplinary team of people involved in milk production	
Step 2 Define milk and its criteria as a final farm product	
Step 3 Identify the intended use of the milk	
Step 4 Design the flow diagram to describe the milk production	
Step 5 Verify the flow diagram in each farm	
Step 6 Hazard analysis: identify, assess, manage, and communicate the hazards (principle 1)	
Step 7 Determine the critical control points- CCPs in the milk production process (principle 2)	
Step 8 Establish the critical limits for each CCP (principle 3)	
Step 9 Design and establish the on-farm monitoring system for all CCPs (principle 4)	
Step 10 Establish corrective measures when deviations from critical limit occurs (principle 5)	
Step 11 Establish a system of documentation and record keeping (principle 6)	
Step 12 Establish verification procedures through audits (principle 7)	
Source: Cullor, 1995; Vilar et al., 2011	

Appendix 3

App. 3	Particular Clauses of BRC Standards
Clause	**Requirements**
3	Food safety and quality management system
3.2	Documentation control
3.2.1	The company shall have a procedure to manage documents which form part of the food safety and quality system. This shall include: ● A list of all controlled documents indicating the latest version number ● The method for the identification and authorization of controlled documents ● A record of the reason for any changes or amendments to documents ● The system for the replacement of existing documents when these are updated.
3.3	Record completion and maintenance
3.3.1	Records shall be legible, retained in good condition and retrievable. Any alterations to records shall be authorized and justification for alteration shall be recorded. Where records are in electronic form these shall be suitably backed up to prevent loss.
3.3.2	Records shall be retained for a defined period with consideration given to any legal or customer requirements and to the shelf life of the product. This shall take into account, where it is specified on the label, the possibility that shelf life may be extended by the consumer (e.g. by freezing). As a minimum, records shall be retained for the shelf life of the product plus 12 months.
3.7	Corrective action
3.7.1	The company shall have a documented procedure for handling non-conformances identified within the scope of this Standard to include: ● clear documentation of the non-conformity ● assessment of consequences by a suitably competent and authorized person ● identification of the corrective action to address the immediate issue ● identification of an appropriate timescale for correction ● identification of personnel with appropriate authority responsible for corrective action ● verification that the corrective action has been implemented and is effective ● identification of the root cause of non-conformity and implementation of any necessary corrective action
3.8	Control of non-conforming product
3.8.1	There shall be documented procedures for managing non-conforming products which include: ● The requirement for staff to identify and report potentially non-conforming product ● Clear identification of non-conforming product, e.g. direct labeling or the use of IT systems ● Secure storage to prevent accidental release, e.g. isolation areas ● Referral to the brand owner where required ● defined responsibilities for decision making on the use or disposal of products appropriate to the issue, e.g. destruction, reworking, downgrading to an alternative label or acceptance by concession ● records of the decision on the use or disposal of the product ● records of destruction where product is destroyed for food safety reasons
3.9	Traceability

3.9.1	Identification of raw materials, including primary and any other relevant packaging and processing aids, intermediate/semi-processed products, part-used materials, finished products and materials pending investigation, shall be adequate to ensure traceability
3.9.2	The company shall test the traceability system across the range of product groups to ensure traceability can be determined from raw material to finished product and vice versa, including quantity check/mass balance. This shall occur at a predetermined frequency and results shall be retained for inspection. The test shall take place at least annually. Full traceability should be achievable within four hours
3.9.3	Where rework or any reworking operation is performed, traceability shall be maintained
3.10	Complaint handling
3.10.1	All complaints shall be recorded, investigated and results of the investigation and root cause of the issue recorded where sufficient information is provided. Actions appropriate to the seriousness and frequency of the problems identified shall be carried out promptly and effectively by appropriately trained staff
3.10.2	Complaint data shall be analyzed for significant trends and used to implement ongoing improvements to product safety, legality and quality, and to avoid recurrence. This analysis shall be made available to relevant staff
3.11	Management of incidents, product withdrawal and product recall
3.11.2	The company shall have a documented product withdrawal and recall procedure. This shall include as a minimum: ● identification of key personnel constituting the recall management team, with clearly identified responsibilities ● guidelines for deciding whether a product needs to be recalled or withdrawn and the records to be maintained ● an up-to-date list of key contacts or reference to the location of such a list, e.g. recall management team, emergency services, suppliers, customers, Certification Body, regulatory authority ● a communication plan including the provision of information to customers, consumers and regulatory authorities in a timely manner ● details of external agencies providing advice and support as necessary, e.g. specialist laboratories, regulatory authority and legal expertise ● a plan to handle the logistics of product traceability, recovery or disposal of affected product and stock reconciliation The produce shall be capable of being operated at any time
5	Product control
5.5.2	Laboratory testing
5.5.2.1	Pathogen testing shall be subcontracted to an external laboratory or, where conducted internally, the laboratory facility shall be fully segregated from the manufacturing site and have operating procedures to prevent any risk of product contamination
5.5.2.2	Where routine testing laboratories are present on a manufacturing site, they shall be located, designed and operated to eliminate potential risks to product safety. Controls shall be documented, implemented and shall include consideration of the following: ● design and operation of drainage and ventilation systems

	• access and security of the facility • movement of laboratory personnel • protective clothing arrangements • processes for obtaining product samples • disposal of laboratory waste
5.5.2.3	Where the company undertakes or subcontracts analyses which are critical to product safety or legality, the laboratory or subcontractors shall have gained recognized laboratory accreditation or operate in accordance with the requirements and principles of ISO 17025. Documented justification shall be available where accredited methods are not undertaken
5.5.2.4	Procedures shall be in place to ensure reliability of laboratory results, other than those critical to safety and legality specified in 5.5.2.3. These shall include: • use of recognized test methods, where available • documented testing procedures • ensuring staff are suitably qualified and/or trained and competent to carry out the analysis required • use of a system to verify the accuracy of test results, e.g. ring or proficiency testing • use of appropriately calibrated and maintained equipment

Appendix 4

App. 4	Indicators in Direct Relation to Food Safety	
Area	**Indicator**	**Selection criteria**
Decision-making on QA	Identify critical control points	•Core assurance activities that affect food safety performance
	Validation	
	Traceability	•Fundamental requirement of BRC standard
Quality behavior	Training	•Barriers to the application of QA systems
	Supervision and support schemes	
Auditing and certification	Sampling & laboratory testing	•Core assurance activity that affect food safety performance
	Documentation & record	•Barrier to ensure food safety transparent •Fundamental requirement of BRC standard
	Corrective actions	•Fundamental requirement of BRC standard •Cause of melamine crisis
Farming practices	Identification system	•Major must control point on the livestock base of GlobalGAP standard
	Animal health	•Major must control point on the dairy base of GlobalGAP standard
Collection stations	Regularly milking	•Crime site of melamine adulteration •Major must control points of GlobalGAP standard
	Withdrawal period	
	Worker hygiene	
	Milking	
	Chemicals	
	Parlor condition	
	Clean potable water	
	Milking/cooling equipment hygiene	
Distribution	Quality control prior to/during transportation	•Major BRC requirements
	Cleaning procedure	•CCP of HACCP system
Milk reception	Inspection	•CCPs of HACCP system
	Hygiene condition	
	Filtration	
	Storage	
Transformation	Heating time & temperature	•CCPs of HACCP system
	Cooling pasteurized milk	
	Pasteurization equipment design	
	Equipment cleaning	
	Factory layout	
Retail practices	Traceability	•CCP of HACCP system
Final food preparation	Expiration date	•CCP of HACCP system

Appendix 5

App. 4	Distributing of Processing Manufactories of Top 4 Dairy Processing Enterprises in China		
Enterprise Name	**District**	**The Number of Processing Factories**	**Daily Processing Capability (Ton)**
Sanyuan	Beijing	7	1227
	Tianjin	1	100
	Inner Mongolia	2	350
	Shanghai	2	130
Bright	Beijing	4	360
	Tianjin	1	300
	Heilongjiang	1	1000
	Inner Mongolia	1	350
	Shanghai	4	3750
	Jiangsu	2	250
	Henan	1	140
	Hubei	1	128
	Hunan	1	80
	Guangdong	1	300
	Shanxi	1	200
Mengniu	Beijing	1	250
	Inner Mongolia	2	5700
	Henan	1	800
Yili	Beijing	1	500
	Hebei	2	360
	Inner Mongolia	2	5600
	Shanghai	1	280
	Heilongjiang	2	240
	Shanxi	1	800
Source: Chen et al., 2008; original source from "China Dairy Statistical Report, 2005"			

Appendix 6

Milk Powder Quality and Safety Performance Evaluation

Questionnaire for China's Dairy Chain

中国乳业链奶粉质量安全评估调查

November, 2011

Prepared by Wei Geng, Wageningen University, the Netherlands
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Wei.geng@wur.nl

Introduction (引言)

Dear sir/madam,

Will you help to investigate the main issues of upgrading food safety within China's dairy chain?

You can help by filling in this evaluation questionnaire.

The researcher of this project is keen to explore the extent to which milk powder produced in China is able to comply with stringent standards of EU for food quality and safety concerning the whole dairy chain as well as the potential challenges and solutions to the upgrade of China's dairy chain.

This questionnaire is developed to examine the validation of food safety activities in China's dairy chain compared with the extracted food quality and safety indicators, which are extracted from (1) major concepts of quality assurance (QA) systems; (2) requirements of major public and private food safety standards of EU (HACCP system, GlobalGAP, and BRC standards); (3) core QA activities during the adoption of QA systems in other countries' dairy sector based on existing literature. 31 indicators that have most closely relation to food safety are developed in this questionnaire. The respondents can be divided into the following five groups: (1) researchers from university and research institute; (2) staff members of government; (3) staff members of certification agency; (4) members of dairy association; (5) staff members/workers in highly modern dairy company.

The response from you will contribute to the overall assessment of food quality and safety activities in current China's dairy sector.

Thank you for your help.

Wei Geng
MSc Food Technology
Wageningen University

尊敬的女士、先生：

由衷感谢您参与本次问卷调查！

本问卷为硕士论文而设，旨在探究中国奶粉在整个生产链中以何种程度满足欧盟食品质量安全标准，以及在提高中国乳制品食品安全过程中亟待解决的问题及相应措施。

本问卷的目的是调查中国奶粉生产在整个乳业链中的安全性，其中涉及 31 个质量安全指标。这些指标源于：（1）质量保证体系（Quality Assurance System）概念；（2）欧盟食品安全标准 （即典型的质量保证体系，如 HACCP 体系，GlobalGAP 认证标准，BRC 食品安全标准）；（3）现存文献关于在其他国家乳品业中执行质量保证体系所需注意的重要指标。本问卷的受调者分为五类：（1）大学及研究机构的专家；（2）政府职员；（3）质量认证机构职员；（4）乳业协会会员；（5）大型乳制品公司职员。

您的答复将有助于评估中国奶粉质量安全的现状。非常感谢您的帮助！

耿威
食品技术硕士研究生
荷兰瓦格宁恩大学

Personal Detail (个人信息)

Name (姓名): _____

Occupation & Position (职业&职位): _____

Work/research field (工作/研究领域): _____

Sex (性别): _____

Today's date (日期): _____

City (城市): _____

Telephone (电话): _____

E-mail address (邮箱): _____

Instructions for Completing the Questionnaire (问卷说明)

This questionnaire is in electronic format to facilitate its completion. Please type your response in the space provided. Five scores from 0 to 4 will be used to answer questions from. In scoring your responses, please follow the spirit of the following definitions:

0 No indication of activity	The specific food safety activity is absent, not present, not conducted
1 Low level of validation	Activities that use of own experience, not standardized, unstable, problem driven, scarcely reported, no independent positions, and regularly problems
2 Medium level of validation	Activities that use of (sector, governmental) guidelines, based on expert knowledge, standardized, regular reporting, and restricted problems
3 High level of validation	Activities that use specific information/criteria, scientific knowledge, systematic activities, independent positions and having no safety problems
4 I don't know	The validation of specific food safety activity is not known by the respondent

本问卷为电子格式，请您对每个食品质量安全指标进行打分。0-4 分分别定义如下：

0 完全没有履行	质量安全指标完全没有实施，不存在
1 履行力度很差	根据自身经验，无标准化，不稳定，出现问题才履行，几乎无报告，没有独立部门执行，经常出现食品质量安全问题
2 履行力度中等	根据政府对乳制品工业下发的指导方针，获取专家意见，标准化，定期报告，很少出现食品质量安全问题
3 履行力度良好	根据具体的标准要求（例如细化到具体的原料奶收集操作规范）， 具备科学知识、质量管理体系 、以及独立部门监管， 无食品质量安全问题出现
4 不了解，不知如何选择	受调者不了解质量安全指标是否实施

Questionnaire Content (问卷内容)

This questionnaire contains both managerial aspects and technological aspects on quality assurance. The indicators from technological aspects covering all stages of dairy chain, including farmers, milk collection stations, dairy processors, distribution, wholesalers/retailers, and consumers. It is important to note that the dairy processors refer to highly modern processors in this research, which have the best chance to comply with EU standards and make the export of milk powder to the EU possible.

本问卷包含管理方面和技术方面两部分。其中技术部分的质量安全指标覆盖乳业链中的所有阶段，包括奶农，原料奶收购站，乳品加工商，运输，批发商/零售商，以及消费者。值得注意的是，本调查中涉及的乳制品加工企业为大型现代化乳品企业，因为此类乳品企业最有可能满足欧盟食品质量安全标准，从而使国产奶粉出口欧洲成为可能。

Section 1 Managerial Aspects on Quality Assurance （质量保证管理部分）

A	Managerial aspects on quality assurance （质量保证管理部分）	Score (分数)				
A 1	**Decision-making on quality assurance 质量保证决策**	**0**	**1**	**2**	**3**	**4**
A 1.1	Identify critical control points 确定关键控制点 Critical control points are defined in the milk powder production line where potential hazards for food safety can be prevented or reduced to an acceptable level 定义奶粉生产过程中的关键控制点以阻止或降低食品安全危害到可接受的范围					
A 1.2	Validation 验证 Validation activities are established in a dairy company to ensure in advance the effectiveness of designed CCPs, control measures, and monitoring systems 奶粉加工过程中提前验证关键控制点的设定、控制方法、及监控系统的有效性					
A 1.3	Traceability 可追溯性 The dairy companies are able to identify and trace all materials from their supplier include raw milk and packaging materials as well as the finished milk powder product dispatched to their customers; The companies test the traceability system at least annually 乳品公司具有追溯所有原材料（原料奶、包装材料）到供应商，所有奶粉商品到顾客的能力；可追溯系统每年至少测试一次					
A 2	**Quality behavior 质量行为**	**0**	**1**	**2**	**3**	**4**
A 2.1	Training 培训 Training or continuing education on food safety for all foodservice workers at all levels of dairy chain, including the milker; Regular refresher training for all staff members and occasional specialized training for specific quality staff in a dairy company; Additional knowledge from professionals that maintain and continually improve the system 乳业链中各个阶段的食品服务人员都接受培训及再培训，包括挤奶工；其中乳品加工企业中涉及食品质量的职员和临时工需定期培训；具备维持并提高质量管理体系的专业知识					

A 2.2	Supervision and support schemes 监督及支持方案 Effective supervision regarding food safety; Food consultants can provide a formal conceptual framework of quality management to locate technical aspects 有效地进行食品安全监督；食品顾问提供正式的质量管理概念架构来定位具体的技术操作					
A 3	**Auditing and certification 审核与认证**	**0**	**1**	**2**	**3**	**4**
A 3.1	Sampling & laboratory testing 抽样检测 Structured sampling (with fixed frequency and company own sampling plan is present) conducted on raw materials, final milk powder product and environmental samples to confirm food quality and safety performance (including microbiological and chemical hazards) 对原材料、奶粉终产品、及环境进行结构化抽样（固定的频率及抽样计划）以确保食品质量安全（包括微生物危害及化学危害）					
A 3.2	Corrective actions 改进措施 The dairy companies use the information from identified failures in food safety and quality management system to make necessary corrections and prevent recurrence; There have a documented procedure for handling non-conformances to identify corrective actions, appropriate timescales and personnel responsibility; Verification has been effectively implemented 乳品加工企业对已证实的食品质量安全体系的不足进行必要的改进；文件记录处理不合格产品的程序从而利于确定改进措施，改进所需时间，及员工责任；有效进行核查工作					
A 3.3	Documentation & record 记录说明 Structured documentation system that keep-up-to-date with assigned responsibilities and on-line available for all staff; Full registration/record of critical product and process data and accessible to all staff on-line 结构化的文件记录系统随时更新责任分配并对所有员工即时可得；完整记录关键的产品加工过程并对所有员工即时可得					

Section 2 Technological Aspects on Quality Assurance （质量保证技术部分）

B	Technological aspects on quality assurance (质量保证技术部分)	Score (分数)				
	Stage: Farmers 阶段：奶农					
B 1	**Farming practices 农业活动**	**0**	**1**	**2**	**3**	**4**
B 1.1	Identification system 身份识别系统 Each milking cow is identified by individual ID (ear tag or neck-chain); a mechanism of identification is used to identify specific dairy cattle 每只产奶牛都具有单独标识（耳上标签或颈链）；具备鉴定机制来识别特定的产奶牛					
B 1.2	Animal health 动物健康 All farms have a named veterinary surgeon or practice who visit on-site at least annually with the veterinary health plan (VHP) show routine preventative treatments (e.g. food care, mastitis prevention, vaccination and worming programs etc.); Each farm is equipped with suitable facilities to isolate sick or injured cows 每个农场都具有至少一个兽医，每年至少视察一次农场，并提供兽医健康计划（VHP）进行常规预防（例如膳食、乳腺炎预防、疫苗、及杀虫剂除虫）；每个农场都配备合适的设施隔离受伤或生病的奶牛					
	Stage: Milk collection stations 阶段：原料奶收集站					
B 2	**Collection stations 收集站**	**0**	**1**	**2**	**3**	**4**
B 2.1	Regularly milking 定期挤奶 Cows in milk are milked regularly 产奶牛定期挤奶					
B 2.2	Withdrawal period 停药期 Medicine use is recorded to ensure that milk from cows within the withdrawal period for any medicine is disposed and does not enter the food chain 记录药物使用以确保处于任何药物停药期的奶牛所产的奶不进入乳业链					
B 2.3	Worker hygiene 工人卫生 Clean suitable garments are worn by people involved in the milking process with clean arms and hands; Workers suffer from notifiable diseases are kept away from all aspects of work in and related to the milking parlor 工人在挤奶过程穿干净的工作服并清洁手臂和手；患有法定传染病的工人远离所有涉及挤奶厅的工作					
B 2.4	Milking 挤奶 Teat washing and disinfection before milking is controlled; The raw milk is cooled down as rapidly as possible after milking with simultaneous stirring for uniform cooling; The temperature and pH are controlled within the right range 挤奶前清洗并消毒奶头；挤奶后所得原料奶被迅速冷却同时搅拌以确保均匀冷却；控制温度和 pH 值					
B 2.5	Chemicals 化学制剂 Instructions for use are strictly followed where chemicals, pesticides or cleaning agents are used; Only chemicals which are registered by official bodies for use on a dairy farm are used and stored in a clean manner and remote from the milking facilities 使用化学品、杀虫剂、及洗涤剂时严格按照说明书使用；只使用官方注册可用于乳牛场的化学制剂；保存在整洁的环境并远离挤奶设施					

B 2.6	Parlor condition 挤奶厅 (1) no evidence of vermin, birds or domestic pets; (2) no potential hazard of glass contamination from vulnerable lights; (3) walls, doors and floors are easily cleanable; (4) sufficient lighting for cows to see and function efficiently; (5) external doors and windows are sound and weather-proof; (6) no mess or rubbish as harborage for vermin; (7) clean equipment; (8) no excessive dust, no smoking; (9) well drained floors （1）无害虫、禽类、及家养宠物；（2）易碎的照明灯不存在潜在玻璃污染；（3）易清洁的墙壁、门、及地板；（4）充足的照明；（5）门窗结实防风雨；（6）无杂乱无垃圾以滋生害虫；（7）设备洁净；（8）无灰尘无吸烟；（9）地板排水性良好					
B 2.7	Clean potable water 干净的饮用水 Cows have access to sufficient clean water; Clean running water for cleaning of dirty cows, rump bars and floors during milking; potable water for the cleaning of milking machines 奶牛可接近充足干净的水源；干净的流水清洗奶牛身体及地板；饮用水清洗挤奶设备					
B 2.8	Milking/cooling equipment hygiene 设备卫生 Correct cleaning and disinfection with detergent dose, water temperature and rinse; Reviews and periodic maintenance 正确清洗和消毒（注意洗涤剂剂量、水温及排水）；检查并定期维护					
Stage: Distribution 阶段：运输						
B 3	**Distribution 分布**	**0**	**1**	**2**	**3**	**4**
B 3.1	Quality control prior to/during transportation 运输及运输前期的质量控制 Prior to raw milk transportation the driver monitors the temperature and acidity of milk using portable thermo- and pH-meters, records of loading temperatures are kept; During transportation the milk temperature is not exceed 10 ℃, the temperature of milk tank is checked with Time-Temperature indicators 运输之前司机控制原料奶的温度和酸碱度并记录；在运输过程中原料奶温度不得超过 10°C；使用时间-温度指示器检测储奶槽的温度					
B 3.2	Cleaning procedure 清洁程序 Documented cleaning procedures are maintained for all vehicles and equipment used for loading/unloading 对所有奶槽车及设备的清洁程序进行文件记录					
Stage: Dairy processors 阶段：乳品加工公司						
B 4	**Milk reception 原料奶收集**	**0**	**1**	**2**	**3**	**4**
B 4.1	Inspection 检测 The dairy companies conduct general quality inspection for temperature, acidity and antibiotic residues which have allergic reactions to penicillin 检测原料奶质量，主要检测内容为温度、酸度、及抗菌素残留					
B 4.2	Hygiene condition 卫生条件 Strict hygiene conditions during milk reception and appropriate cleaning with sufficient disinfection of milk containers are adopted; The control measures include duration of cleaning time, temperature and concentration of disinfectants; The effectiveness of the cleaning method are controlled and regularly checked 收集原料奶的场地有严格的卫生要求，储奶槽用洗涤剂清洗；控制卫生条件的措施包括清洗时间间隔、温度、及洗涤剂浓度；定期检查清洁工作是否有效					
B 4.3	Filtration 过滤					

	The filters are frequently changed to prevent sediments act as milk contaminants 过滤器经常更换以防止沉积物污染					
B 4.4	Storage 储存 Raw milk is kept at the lowest possible temperature and treated within 72 h; Silo tanks are provided with stirring system for the uniform cooling of milk; Daily cleaning schedules for silo tanks are set up and documented 原料奶在尽可能低的温度下于 72 小时内被处理；储奶罐配有搅拌系统使均匀冷却；文件记录每日清理储奶罐					
B 5	**Transformation 产品转化**	**0**	**1**	**2**	**3**	**4**
B 5.1	Heating time & temperature 加热温度与时间 The heating time and temperature are strictly controlled and checked in the pasteurization step; Corrective actions are taken based on the records of pasteurization parameters 巴氏灭菌过程中严格控制加热时间和温度；根据记录的灭菌参数执行改进措施					
B 5.2	Cooling pasteurized milk 冷却 Leaks in the barrier between the milk and the cooling fluid are predicted; The pressure difference between pasteurized and untreated milk is tested and calibrated 注意灭菌奶与冷却液之间的相互渗透；测试并校准灭菌奶和未处理奶之间的压力差					
B 5.3	Pasteurization equipment design 灭菌设备设计 The pasteurization equipment is properly designed and meticulously operated; Automatic safety system to prevent too low or too high temperatures 认真操作巴氏灭菌设备；自动安全系统阻止过高或过低的温度					
B 5.4	Equipment cleaning 设备清洁 Cleaning and disinfection procedures of the heating equipment are optimized and programmed; Duration, temperature and concentration of the cleaning solution are checked and records are kept 优化对加热设备的清洗消毒；文件检测并记录清洗间隔、水温、及洗涤剂浓度					
B 5.5	Factory layout 工厂设计 The environment is an important aspect of the processing line after pasteurization, tight barrier between the product and its environment is designed to prevent cross-contamination 灭菌后所处的环境十分重要，在灭菌后产品和外界环境之间设计坚实的阻隔以避免交叉污染					
Stage: Wholesalers/retailers 阶段：批发商/零销商						
B 6	**Retail practices 零售活动**	**0**	**1**	**2**	**3**	**4**
B 6.1	Traceability 可追溯 Each wholesaler, or retailer should at least be able to ensure that milk powder products in their control are traceable to the supplier; The system should be reviewed at least yearly to ensure that it is delivering the required level of traceability 每一个批发商/零销商都确保奶粉产品可追溯到供应商阶段；可追溯体系至少每年检测是一次					
Stage: Consumers 阶段：消费者						
B 7	**Final food preparation 最终食品准备**	**0**	**1**	**2**	**3**	**4**
B 7.1	Expiration date 产品有效期 No expired milk powder reaches its consumers 消费者不接触过期奶粉					

Open-questions (开放问题)

Please answer the following open-questions in English or Chinese.
请任意用中文或英文回答下面问题。

Please use the space below to suggest what you think should be the challenges for China's dairy chain to comply with quality assurance systems and food quality and safety standards of EU:
（请用下面的空间提议您认为中国乳业链在服从质量保障体系及欧盟食品质量安全标准的过程中所面对的挑战是什么）

Please use the space below to propose what you think should be the possible strategies for China's dairy sector to produce milk powder in accordance with quality assurance requirements and EU standards:
（请用下面的空间提议您认为有哪些可行的策略可以使中国奶业按照质量保证体系及欧盟标准进行奶粉生产）

Please use the space below to state your additional comments you might have:
（请用下面的空间给出对此次问卷调查的建议）

Thank you for your time! 感谢您的支持和参与!

Appendix 7

App. 7	Record of interviews
Interviewee	**Content**
What are the key challenges to upgrade the quality and safety of China's dairy chain and What are the reasons and accompanying solutions to these challenges?	
Traceability	
Member from China Dairy Industry Association	There are three batches a day for raw milk collection in each cattle farm, the raw milk is mixed together after mechanical milking, you can trace back to the specific batch, but it's not possible to trace back to specific dairy cow
Quality controller from Yili Group	Raw milk sample from each dairy cow is preserved before mixing, tracing back to specific cow is not a problem. But the data is recorded in document, not computer.
Deputy director from MOA	For the district around modern cities there's no problem to accomplish electronic records, for the other districts maybe still use written records
Training	
Member from China Dairy Industry Association	The government undertook training of dairy farmers regularly, but the quality of dairy farmers is a big problem, they are poor and have no education background, they do not necessarily operate according to the training
Researcher from Inner Mongolia Agricultural University	The farmers may not totally understand what they learned. Also, maybe the training cannot meet the real needs of the farmers. The vertical integration would be the only way to solve this situation. From my experience, they care more about animal health than food safety behavior
Quality controller from Yili Group	There's no profit motivation for dairy farmers
Supervision and support schemes	
Researcher from Inner Mongolia Agricultural University	The responsibilities from different government departments were not clear, and in the end, nobody in the authority was available to take specific responsibility especially for the numerous private milk collection stations. Thus, the government responsibilities from different departments are overlapped, making clear responsibilities is necessary
Corrective actions	
Inspector from Yili Group	Sometimes we report problems to the managers but receive no reply. The managers should engage employee involvement
Documentation & record	
Member from China Dairy Industry Association	The documentation and records could be easily falsified. Electronic record will improve this situation to some degree
Inspector from Yili Group	The workers take the responsibility to record per hour, if they miss out one data, it is possible to falsify because usually the fluctuating range of data is stable. Punishment is necessary in this matter
Identification system	
Quality controller from Yili Group	For some small farms, there's no ID tag because the farmers can recognize their cows visually, or they can paint a sign with color on the tail of the cow

Animal health	
Quality controller from Yili Group	Sometimes two farms share one veterinary and no structured VHPs with documents
Deputy Director from MOA	Every farm can always reach veterinaries for free. The preventative treatments performed very well
Worker hygiene	
Quality controller from Yili Group	Sometimes milkers from private milking station do not wear working clothes and wash arms and hands
Parlor condition	
Inspector from Yili Group	Sometimes the cow dropping is not cleaned immediately in small farm
Milking/cooling equipment condition	
Quality controller from Yili Group	Sometimes use less concentration of detergent to reduce washing times
Quality control prior to/during transportation	
Quality controller from Yili Group	The milk collection station outsourcing raw milk transportation to uneducated driver with a truck, regular inspection is conducted by dairy companies
Cleaning procedure	
Quality controller from Yili Group	Cleaning is performed very well in summer, not very well in winter because the washing water is easy to be frozen in the truck
Expiration date	
Member from Shanghai Dairy Association	The flavor, state, and bacteria content are changed before the expiration date. One reason is because of the poor raw milk quality. Bacteria count 2,000,000/ml (100,000/ml in Europe) based on the "National Food Safety Standard – Raw Milk" cannot guarantee good raw milk quality. In addition, ultra-high-temperature processing is the main sterilization method in China rather than pasteurization, the extreme heat temperature cause significant losses in protein stability. The existing standards only refer to end products, raw milk and milk powder ("National Food Safety Standard – Raw Milk" and "National Food Safety Standard – Milk Powder"). I suggested drafting new standard for dairy processing during the meeting with MOA, but the government official rejected the proposal because they think there's no need to lay down dairy processing standard to hamper the initiative of dairy enterprises.
The import in the EU of milk products from China has been prohibited under EU legislation since January 2002, saying that the Chinese residue pesticide system did not reach standards set down by the EU, to what degree do you think the residue pesticide system has been improved?	
Member from China Dairy Industry Association	The residue pesticide system is not making much progress, the gap of categories and legal maximum of residue pesticide between China and the EU is very wide indeed
Member from Shanghai Dairy Association	A quarter of dairy production is from "District around modern cities", where has built a good grounding in food safety performance, like Beijing, Shanghai, Tianjin, and Guangzhou. Improving food safety according to the export requirements of the EU can be fully completed
Do you think the application of QA systems in China will cause resistance to change? Which change strategy is more	

suitable to China's dairy industry, force-coercion with rewards and punishments, rational persuasion depends to expert power or shared power with high level of employee involvement?	
Researcher from Inner Mongolia Agricultural University	Shared power strategy is quite time-consuming, so I would say force-coercion strategy. Although the outcomes are lack of commitment, the advantages outweigh the disadvantages. It would be better to combine force-coercion and rational persuasion strategy
Member from China Dairy Industry Association	Force-coercion strategy
Member from Shanghai Dairy Association	Force-coercion strategy
I've already consulted some experts and they suggested lying down new national dairy processing standards, what's your opinion on this?	
Deputy director from MOA	There are enough standards on dairy processing, referring pesticide residue, animal feed, aflatoxin, etc. I advise you to do more practical investigation yourself and not to believe what the other people said.
Are the cost and sufficient time involved in implementing and continually maintaining QA system and tailor EU assurance activities for specific characteristics of China's dairy chain barriers?	
Researcher from Inner Mongolia Agricultural University	To tailor EU assurance activities and strengthen food safety in every stages and points along China's dairy chain is time-consuming because the levels are various between different districts
Member from China Dairy Industry Association	The cost is a problem, it's impossible to up to EU standard across the country in the short run
Member from Shanghai Dairy Association	Sufficient time is a barrier, most of dairy enterprises put emphasis on sales

Appendix 8

App. 8	Summary of interviews and brief analysis
Subgroup 1: researchers from university/research institute (1 interviewee)	
The researcher from Inner Mongolia Agricultural University has been engaged in the investigation of farmer stage since 2004. She totally understands the difficulties faced by small farmers. All educated young people are willing to work in cities, only the numerous poor uneducated farmers stay in the countryside and raise dairy castles. It is difficult to have desired effect on training and supervision. Therefore, she proposed to integrate dairy chains by organizing small farmers to local cooperatives or dairy processors. This will ensure food safety on one hand and help the small farmers make profits on the other hand.	
Subgroup 2: staff members of government (1 interviewee)	
The deputy director from MOA-Milk and Dairy Product Inspection Center didn't fill in the questionnaire but accepted the interview. He didn't give clear answer to any questions during the interview. He emphasized the importance of practical in-depth investigation and suggested the researcher do not believe what the other people said. When the researcher raised doubts about the application of traceability in dairy sector, he didn't give direct answers but pointed out the differences between cities. In modern cities traceability performed very well according to his statement. The deputy director also emphasized that the dairy chain integration had been suggested but unfeasible to the present time.	
Subgroup 3: members of dairy association (2 interviewees)	
The member from China Dairy Industry Association accepted the interview anonymously. He confirmed that the frequency of inspection on raw milk quality was greatly increased after the melamine crisis. He also expressed strong discontent over the new standard on raw milk, which was considered as a backward step on bacteria count. However, with regard to the export of composite products from China, he called for changing an attitude of exclusion on Chinese dairy products. He believes that Chinese dairy industry is qualified to satisfy stringent EU standards. The member from Shanghai Dairy Association felt free to answer questions during the interview. He interpreted the low scored indicator "Expiration date" – Poor raw milk quality and high temperature treatment (UHT). He advocated making dairy processing standards. But his proposal was turned down by the authority. He was quite confident in the food quality and safety performance in the "District that around modern cities", e.g. Shanghai.	
Subgroup 4: workers from highly modern dairy companies (2 interviewees)	
A quality controller and a quality inspector came from Yili Group accepted the in-depth interviews. Most causes of low scored indicators were explained in detailed by these two respondents. Apart from the explanation of practical operations, they also put forward weak points that specific derived from this subgroup – neglect of corrective reports and worker hygiene problems.	