Managing Upstream Risks in China’s Food Supply Chain
Companies must address the risks associated with China’s unique agricultural landscape.
Managing upstream food safety risks in a highly fragmented industry

The fragmented and rapidly changing nature of China’s agricultural sector poses enormous food safety challenges for corporations that operate in China. Traders, processors, distributors and retailers are all legally responsible for the safety of the food they process or sell. With approximately 190 million farms producing China’s crops, meat and milk, it is difficult to monitor chemical inputs, veterinary medicines, hygiene, and temperature control at every upstream link in the supply chain. Intense price competition in the market for primary agricultural products can tempt producers to prioritise cost efficiency over food safety. And traceability is extremely difficult in this fragmented landscape, making it challenging to identify the root cause of a food safety issue or to conduct product recalls.

By some measures, China’s economy is now as large as that of the US, but the industry structure of the two countries’ agricultural production could hardly be more different. China’s agricultural sector is much more fragmented, and includes far more household farms and small-scale intensive livestock operations.

To ensure the safety of the food they process and sell, companies operating in China must address the risks associated with the unique agricultural landscape. This requires a more granular and interactive approach to supplier relationships than is required in a concentrated and relatively homogenous market, such as the US. There are extra costs associated with ensuring food safety in this environment, but leading corporations cannot afford to keep their China supply chain at arm’s length.

While food safety risks exist throughout the supply chain, this discussion is focused on China’s primary agricultural production. The following sections compare China’s major agricultural sectors with those of the US, describe food safety risks for each sector, and provide examples to illustrate those risks. The purpose of the comparisons is not to comment the merits of the two markets and systems, but rather to support the tailoring of food safety management for local conditions. The final section of this document suggests principles to address upstream food safety risks in China’s highly fragmented environment.
Structural challenges in China’s agricultural sector

Highly fragmented production

China’s crops, meat, and milk are sourced from approximately 190 million farms. The number of farms producing crops in China is approximately 100 times more than the US, while the number of farms raising pigs is nearly 1,000 times more than the US. Not only is traceability incredibly difficult in such a highly fragmented environment, but monitoring suppliers for adherence to standards and regulatory compliance requires significant resources and a sophisticated approach.

China’s government recognises these challenges, and is actively promoting good practices through the introduction of new food safety regulations and by encouraging farming cooperatives, contract farming and demonstration areas. The government is also encouraging vertical integration, most notably in dairy and livestock production.

<table>
<thead>
<tr>
<th>Number of farms with cropland in China (2006) and the US (2012)</th>
<th>Number of farms that raised pigs for slaughter in China (2013) and the US (2012)</th>
<th>Number of farms that raised broilers in China (2013) and the US (2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>184 million</td>
<td>52 million</td>
<td>24 million</td>
</tr>
<tr>
<td>China</td>
<td>China</td>
<td>China</td>
</tr>
<tr>
<td>1.6 million</td>
<td>56 thousand</td>
<td>33 thousand</td>
</tr>
<tr>
<td>US</td>
<td>USA</td>
<td>USA</td>
</tr>
</tbody>
</table>

1. China 2006 Agricultural Census  
2. MOA, Opinions of the Ministry of Agriculture on Constructing National Modern Agricultural Demonstration Zones, 2009  
Small-scale crop production

China's total crop production is among the largest in the world, but there are few large-scale producers. Primary production of crops (including fruits and vegetables) is carried out largely by small household farms. According to the most recent agricultural census in 2006, there were 184 million farms growing crops, with an average of 0.7 hectares of arable land. The United States, in contrast, has about 1.6 million farms with cropland, averaging 102 hectares per farm.

China's rural land rights regulations, dating from the de-collectivisation of agriculture in the 1980s, prohibit private ownership of farmland and restrict the sale of land rights by farmers. While these rules initially spurred economic growth, they now inhibit consolidation of farmland. In order to promote large-scale planting and modernisation, the government is considering reforms to the current land administration system, such as encouraging cooperatives, allowing joint-stock ownership of large-scale farms and permitting the leasing or sale of land use rights. Provinces and municipalities have already been testing various forms of land rights transfers for many years.

Average size of farms with cropland in China and the US

<table>
<thead>
<tr>
<th>Average arable land per farm (hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China 0.7</td>
</tr>
<tr>
<td>US 102</td>
</tr>
</tbody>
</table>

The food safety and traceability challenges inherent in this environment were illustrated by a 2012 norovirus outbreak in Germany that sickened 11,000. The outbreak was linked to a 22-ton lot of strawberries that were harvested and frozen in Shandong province, shipped to a German distributor via Qingdao and Hamburg, then served at more than 380 schools and childcare facilities. Norovirus contamination risk is highest in the production and primary processing stages, but authorities were unable to determine where the contamination of the strawberries took place. (It was also noted that boiling the strawberries prior to serving would have prevented the outbreak.) With limited farmland and rapid economic growth, some industrial and mining operations have been established in close proximity to farmland, creating a risk of industrial pollution. In 2013, the Guangzhou Food and Drug Administration reported that nearly half of 18 rice samples from local markets contained excessive levels of cadmium.

In January 2014, CCTV reported that eight million acres of farmland were no longer usable for growing food due to contamination with heavy metals and other toxic chemicals.
Input-driven growth

China’s total harvest more than tripled between 1980 and 2013, while arable land increased by only 10%. Growth was due mainly to a ten-fold increase in vegetable production. China is now the world’s largest producer of vegetables (over 50% of world production) and fruits (over 20% of world production).\footnote{13. FAO Statistical Yearbook 2014}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{chart.png}
\caption{Increase in China’s major crop production and arable land area 1980-2012\footnote{14. FAOSTAT, World Bank}}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{chart2.png}
\caption{China’s major crop production 1980-2013 (billions of tonnes)\footnote{15. FAOSTAT}}
\end{figure}

13. FAO Statistical Yearbook 2014
14. FAOSTAT, World Bank
15. FAOSTAT
In addition to land reform and new varietals, growth in production has also been driven by increased use of inputs. China’s agricultural sector is one of the world’s largest users of fertiliser and pesticides, and on average its farmers now apply more than four times the amount of chemical fertiliser and more than three times the amount of pesticides per hectare than farmers in the EU or the US. The government has recognised this as an issue and in 2015 the Ministry of Agriculture approved action plans to stop the growth of fertiliser and pesticide use by 2020.16

Chemical fertilisers and pesticides are an integral part of modern agriculture. But there is significant risk of over-application or misuse of chemical inputs given the availability and affordability of fertilisers and pesticides, the difficulty of supervision, and the intensely competitive marketplace. In 2015, China National Radio reported that excessive and inappropriate application of chemical fertiliser had hardened and acidified soil in many Hubei farms, rendering the land useless.19 Analysis of national soil surveys indicates that the average pH of soils in China declined sharply between the 1980s and the 2000s due mainly to nitrogen fertiliser. Several studies have shown high levels of fertiliser-derived nitrate in groundwater.20

In January 2015, the China Daily reported that several types of vegetables from markets in Beijing, Shanghai and Guangzhou tested positive for a variety of pesticide residues, with many exceeding national standards. Approximately 40% of the Beijing samples contained five or more kinds of pesticide residues.21 In 2011, several farmers in Liaoning province were jailed for treating bean sprouts with urea and the antibiotic enrofloxacin.22

---

18. World Bank
24. FAO Statistical Yearbook 2013
Meat production shifting from household farms to intensive livestock operations

China’s meat production was dominated by household farms a few decades ago, but now most pork and poultry comes from small and medium-sized intensive livestock farming operations. This development has reduced fragmentation in these sectors, but even after excluding the more than 50 million small household farms that produce pigs and more than 20 million household farms that produce broilers, China still has more than three million intensive livestock operations producing pigs and broilers compared to fewer than 100,000 in the US.\(^\text{25}\)

Pork production

Between 1980 and 2013 China’s total meat production grew by 400% to meet the increasing demands of a growing middle class.\(^\text{26}\) China produced and consumed more than half of the world’s pork in 2014.\(^\text{27}\)

Between 1980 and 2013 China’s meat production grew by 400%.

Ten years ago, the majority of China’s pork came from pigs raised on small household farms that produced fewer than 50 pigs per year. These farms still account for about one-third of the pigs raised for slaughter. Recent growth has been driven by small and medium-sized intensive farming operations. The majority of pigs produced for slaughter in China still comes from small farms that produce fewer than 500 pigs per year. The fragmented and diverse industry structure in China contrasts with that of the US, where only 56,000 farms raise pigs and 90% of production comes from farms with annual production of more than 5,000.

The majority of China’s pigs are raised on farms that produce fewer than 500 per year.

Industry structure for pig farms in China (2010) and the US (2012)\(^\text{29}\)

---

25. 2012 USDA Census of Agriculture, 2011 China Animal Husbandry Yearbook, (note: farms with annual production of 50 or more pigs or 2,000 broilers are assumed to be intensive livestock operations)
26. FAOSTAT
27. USDA FAS, Peoples Republic of China Semi-Annual Livestock and Products, GAIN Report number CH15009, 9 March 2015
28. FAOSTAT
Supervision and regulatory enforcement over 52 million farms is difficult, especially with the wide range of farm sizes and the mix of household farms and intensive livestock operations. In contrast, buyers and regulators in the US can focus on the risks, standards and best practices associated with a relatively small number of large-scale intensive farms.

Given the short history and rapid growth of intensive farming in China, there is a real risk of insufficient technical expertise at any individual operation. The densification of enclosed livestock populations increases the risk of disease outbreak and contagion within herds and flocks. Managing the health and welfare of a large herd requires optimal nutrition from quality feed sources, and effective control and proper administration of veterinary medicines and growth promoters. These functions require managers with technical expertise and staff who are well trained. Diligent control of all aspects of livestock production and meat processing is required to ensure a safe meat supply chain. Effective bio-security and disease management practices must take priority on intensive livestock farming operations. Diseased animals must not be allowed to enter the food supply chain.

Failing to maintain healthy herds and follow best practices with sick or dead livestock can have disturbing consequences. In March 2013, more than 11,000 dead pigs were found in Shanghai’s Huangpu River and its tributaries. The carcasses were said to have come from nearby Jiaxing prefecture, where about 130,000 pig farms produce about 4.5 million pigs for slaughter each year. In 2015, police seized 1,000 tonnes of meat and 48 tonnes of cooking oil made by a criminal network that bought and processed sick and dead pigs.

The economically-motivated misuse of chemical additives or growth promoters can also pose risks. In 2011 the Ministry of Agriculture launched a crackdown on the use of illegal additives in pig feed. In the same year, authorities in central Henan province seized 18 tonnes of pig feed suspected of containing clenbuterol and arrested 72 people for allegedly producing, selling or using the additive.72

**Broiler production**

China’s production of chicken meat has increased by more than 1200% since 1980. The country is now the world’s second largest producer of chicken meat (behind the US) and the largest producer of eggs. The mass migration from the countryside to cities and the rise of fast food restaurants in China have been the main drivers of consumption growth.

---

33. FAOSTAT
Until the early 1980s most poultry was raised on small household farms. Since then, however, chicken has become China’s most industrialised and vertically integrated area of livestock production. The vast majority of China’s broilers are raised on small and medium-sized intensive farms that produce between 2,000 and 100,000 broilers per year. US producers operate on a much larger scale, with two-thirds of broilers raised on farms with annual production of more than 500,000.

![Diagram showing broilers produced for slaughter in China (2010) and the US (2012)](image)

**Most of China’s broilers are raised on farms that produce 2,000 - 100,000 birds per year.**

Similar to the pork industry, the history of intensive broiler farms in China is relatively short and growth has been rapid. There is a risk that some managers lack the experience and technical expertise to raise flocks according to regulations and good practice. With producers operating on very thin margins, economic motivation combined with a lack of expertise can lead to excessive or improper use of veterinary medicines or chemical additives. Supervision and regulatory enforcement is very difficult with nearly 24 million farms raising broilers, including approximately half a million intensive farming operations. In contrast, regulators and buyers in the US can focus on the risks associated with a relatively small number of very large intensive broiler farms. The US has just over 33,000 farms that raise broilers; and 96% of production is from farms that produce more than 200,000 broilers per year.

Antibiotics are routinely administered to poultry in sub-therapeutic doses to prevent disease, and are sometimes administered in order to accelerate weight gain. Regulations limit the types and quantities of antibiotics administered to livestock, and also specify withholding periods prior to slaughter in order to ensure that meat consumed by humans does not contain excessive antibiotic residue. Regulatory limits notwithstanding, the public perception of antibiotics in meat production is generally negative. In 2012, CCTV reported that small farmers fed chickens large quantities of hormones, antibiotics and banned drugs, and that some farmers violated the regulation requiring farmers to stop administering drugs at least one week before slaughter. In the US, several restaurant chains recently pledged to eliminate some or all types of antibiotics from their chicken meat, a move that could create consumer pressure on other companies to reduce or eliminate the use of antibiotics in their own supply chains.

Researchers at the Chinese Academy of Sciences estimate that up to 84,000 tonnes of antibiotics were administered to animals in China in 2013. The US FDA estimates that less than 15,000 tonnes of antibiotics for animal use were sold and distributed in the US in 2013.

---

34. 2012 USDA Census of Agriculture, 2011 China Animal Husbandry Yearbook
36. Wall Street Journal, Tyson Joins the Flock on Curbing Antibiotics, 28 April 2015
38. US FDA, 2013 Summary Report on Antimicrobials Sold or Distributed for Use in Food-producing Animals
China’s dairy industry is evolving quickly

China’s milk production increased by more than 400% between 2000 and 2010, and is now the third largest in the world behind the US and India. The industry has undergone significant evolution during the past 30 years.

In the early 1980s, milk was collected from small individual farmers by tank trucks and transferred to processing facilities. The establishment of milking stations and direct extraction improved control of temperature and hygiene, reducing food safety risks. In the late 1990s, the introduction of ultra-high temperature (UHT) processing to China provided a breakthrough for the industry by extending shelf-life and overcoming limited cold chain infrastructure. Consumption of milk has become popular among China’s urban population.

A large percentage of China’s 14 million milk cows is owned by small household farms.

39. FAOSTAT
A large percentage of China’s more than 14 million milk cows is still owned by very small household farms; but the industry is increasingly led by large companies that have consolidated processing and distribution capacity and are becoming more vertically integrated. Productivity is rising due to improved farm management practices and the importation of hundreds of thousands of high-producing heifers with more productive and resilient genetics. Improved local cold chains and the growing prevalence of household refrigerators have supported the growth of fresh milk consumption.

In the past decade there has been significant progress in improving food safety in the dairy industry. The leading processors increasingly source raw milk from large, modern dairy farms with professional management and thousands of cows. More and more small farm production is linked to cooperatives and dairy zones that provide technical assistance and supervision and improve management of raw milk quality and safety.

While great progress has been made, the incredibly rapid growth of milk production and the short history of intensive dairy cow operations create the risk of insufficient experience and expertise among management and staff. The rapid growth and intensification of dairy farming in China has increased the risks of contaminated feed and water, and poor disease control. When pesticide and heavy metal residues are present in animal feed, these can enter raw milk and present a food safety risk to consumers. Ensuring the safety of raw milk requires proper administration of approved veterinary medicines for disease treatment. Milk from sick cows must be excluded from the food chain during the required withholding period. There is a risk of cross-contamination from the cow’s udder, milking equipment or milk tankers that have not been properly cleaned and sanitised, as well as from farm staff with poor personal hygiene. Residues from cleaning and sanitising chemicals on equipment can contaminate dairy products, along with foreign matter from pests, packaging materials, equipment or employees. It is essential to ensure effective process and food safety hazard control during milk pasteurisation, processing and packing.

Other ingredients used in the processing of dairy products can introduce microbiological, physical and chemical contamination. Temperature abuse is another key safety risk for dairy products. The growing demand for fresh milk from Chinese consumers is testing the limits of the cold-chain infrastructure.

In 2008, melamine-contaminated milk led to thousands of people becoming ill and to several deaths. The melamine was presumably added to raw milk to boost protein content and conceal economically-motivated dilution. This incident led to the regulatory transformation of the dairy industry, which is still ongoing. Authorities closely monitor infant formula milk powder for non-conformance, regularly publish test results, and quickly order recalls when issues are detected.
Long-term trend towards consolidation in livestock and dairy

The number of large-scale intensive farming operations is growing rapidly, driven by investment from large Chinese companies and multinationals. These large-scale operations currently comprise only a small percentage of China’s total production, but are indicative of a long-term trend towards consolidation and up-scaling.

Government policies generally support consolidation in the food industry as a means to modernise production, increase output and efficiency, enhance food safety, and improve regulatory enforcement and adherence to good practices. Consolidation of processing is proceeding more quickly, especially in dairy, pork and chicken. Consolidation of crop and vegetable production will take longer as this depends on reforms of land rights regulations. In the long run, the industry structure of China’s food sector will increasingly resemble the consolidated structure of the US; but in the short- and medium-term, the industry landscape will remain fragmented and constantly changing.

Farms in China that produced more than 50,000 pigs for slaughter in one year

Farms in China that produced more than one million broilers for slaughter in one year

Farms in China with more than 1,000 milk cows

44. China Animal Husbandry Yearbook
45. China Animal Husbandry Yearbook
46. China Animal Husbandry Yearbook
How we can help corporations address upstream food safety risks in China

Consumers and authorities will hold large companies, especially those with well-known brands, responsible for any upstream food safety failures; and it only takes a single contaminated or spoiled batch to sicken customers and make national headlines. Executives with trading, processing, distribution or retail operations must take active responsibility for the safety of their entire supply network, beginning with the primary producers. An effective approach to food safety in China requires granularity in order to address the highly fragmented industry structure. A high level of interaction with suppliers and service providers will help to ensure the quality of inputs and adherence to regulations and standards.

To better mitigate food safety risks in China’s uniquely challenging food industry landscape, PwC recommends that corporations take the following measures:
1. Be thoroughly familiar with the entire production and supply chain
   • Get to know every vendor in the supply chain with on-site visits, including farmers, traders, primary processors, secondary processors and logistics companies.
   • Verify the quality of the agricultural production environment, including potential water and soil contamination and the proper use of fertiliser, pesticides and growth promoters.
   • Verify the health and welfare status of livestock, the quality of feed and water sources, and the proper use of veterinary medicines.
   • Verify the hygiene and temperature conditions of all processing and logistics steps.

2. Invest in vertical integration and consolidate suppliers
   • Vertical integration enables better control and traceability.
   • Reduce the number of suppliers to help concentrate accountability, increase standardisation, improve visibility and strengthen relationships.

3. Create win-win supplier relationships
   • Provide clear and detailed specifications and key performance indicators, and regularly measure performance and conformance to specifications.
   • Provide suppliers with training and assistance to ensure the implementation of best practices.
   • Provide credit or subsidies for key inputs and raw materials and establish control mechanisms to ensure their proper use.

4. Design an effective monitoring and verification program
   • Continuously identify, evaluate and monitor key contamination, adulteration and fraud risks; recognising that these risks change with market conditions and the industry landscape.
   • Monitoring and verification programs must be risk-based and statistically designed to provide optimal quality assurance for each upstream vendor, as well as for in-house operations.
   • Unannounced audits must be the norm.
   • Verification must go beyond “tick the box” compliance to include comprehensive, risk-based assessment with a focus on continuous improvement.

5. Strive for effective traceability and transparency
   • Ensure the ability to effectively respond to a food safety incident, facilitate timely product recall and implement appropriate crises management.
   • Instil a culture of accountability throughout the supply chain.
   • Transparency builds trust and brand loyalty among customers and illuminates opportunities for efficiency gains.

This report was written by Brian Marterer of PwC China.
Contact us

Amy Cai
PwC China and Hong Kong Priority Services Leader
+ 86 (21) 2323 3698
amy.cai@cn.pwc.com

Samie Wan
PwC China and Hong Kong Food Supply & Integrity Services Partner
+ 852 2289 2019
samie.sm.wan@hk.pwc.com

Wenjing Cao
PwC China Food Supply & Integrity Services Director
+86 (10) 6533 7026
wenjing.cao@cn.pwc.com

Fiona Zhang
PwC China Food Supply & Integrity Services Director
+86 (10) 6533 3669
fiona.x.zhang@cn.pwc.com