



Ministry of Foreign Affairs

Quickscan China Food Processing Waste Streams

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Quickscan China Food Processing Waste Streams



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



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1. Executive Summary

Reducing food losses and -waste is becoming increasingly important in China, as it is linked with current sustainability challenges of food security and climate change. However, the scale of food waste throughout the supply chain remains a complex matter in developing countries such as China. Rapid urbanization drives constant changes and developments in consumption behavior and food processing technologies, so existing information and data have become outdated and fragmented. Consequently, there is also a fairly unclear picture about how certain waste streams are treated and processed, and about how these processes can be improved.

This quick scan outlines four major food categories with information about their waste streams, challenges and potential business opportunities. An overview can be found in Table 1. below, which is the summary of the desk and field research conducted and described in further detail in this report.

There is huge potential in sustainable use of certain waste streams such as fish, vegetables and fruit, considering the great waste of resources when it is discarded. Moreover, it also brings a tremendous negative environmental impact. When this potential is successfully utilized for feeding livestock, for example, it can contribute to the development of a more self-sufficient food chain.

Food Category	Loss and/or waste Amount	Waste streams (by-products)	Comment treatment	Opportunity	Challenge
<i>Grains</i>					
- Rice	7.5 million tons (loss)	Rice husk	Mostly discarded or incinerated	Bioethanol, biobutanol, activated carbon and adsorbent.	The over-processing not only reduces output rate and increases the cost for rice processors, but also deteriorates the nutritional value of rice.
		Rice bran	Mostly discarded or incinerated	Food base material	
		Broken rice	Mostly discarded or incinerated	For processing and making drinks.	
- Soy bean	11.85 million tons	Soybean meal	Animal feed	Soymeal is a key ingredient for feed, due to its good amino acid composition.	Because the moisture content is large, transportation is difficult, and easy to rot, it is difficult to process soybean dregs. The high cost of drying soybean dregs hinders the comprehensive utilization of soybean dregs
		Soybean dregs	Processed into food		
<i>Aquaculture</i>					
- Fish	2.5 million tons	Fish heads & bone	Mostly discarded or discharged into nearby waters	increase efficiency in harvesting, storage, and distribution stages, and fishmeal for fish feed	lost at the harvesting, storage, and distribution stages, great waste of resources
		Viscera	Mostly discarded or discharged into nearby waters		
		Fish scales	Mostly discarded or discharged into nearby waters		
		Fish skin	Mostly discarded or discharged into nearby waters		
<i>Vegetables & Fruit</i>					
- Vegetables (in general)	100 billion tons		Anaerobic digestion (degrade)	increase efficiency in harvesting, storage, and distribution stages,	lost at the harvesting, storage, and distribution stages and because of its high moisture content, not suitable for the incineration processes. Due to the high content of organic components, a large number of leachates will be produced by stacking or landfilling, which results in serious environmental pollution.
			Anaerobic fermentation (composting)		
			Feed protein (silage, processing feed protein and feed powder)		
			Sewage treatment (pretreatment of industrial wastewater)		
- Citrus	2 million tons	Citrus peel	Mostly treated as waste	extract essential oils or produce ethanol fuel and feed	Great waste of resources, and also pollutes the environment

Table 1. Overview of the challenges and opportunities in different waste streams

2. Introduction

China needs to feed 1.4 billion people, one fifth of the world's population, with changing consumption habits. The country has become increasingly reliant on imports to account for these changing consumption habits and finds itself running a food trade deficit¹. The results are an unsustainable supply of food. This has prompted Beijing to openly reframe its food self-sufficiency strategy and its focus on battling food waste. The most recent indication of this focus has been the Food Conservation Action Plan from 2021 in which the conservation and loss reduction in the whole grain supply chain and the effective utilization of by-products has been emphasized².

This quick scan outlines examples of post-harvest waste streams from the major food categories in China and explains the relevance of the Yangtze River Delta area. China's major food processing companies recorded combined profits of 535.96 billion yuan (about 82.92 billion U.S. dollars) in the first 11 months of 2020, up 6.8 percent year on year³. Examples will be provided of food processing waste streams that are important in the YRD region, such as rice, fish and citrus based on the major food categories. Other regions will have other important categories, such as dairy, potato, sugar, etc. The analysis of this report will point towards the major issues of food loss and -waste in China and where potential business opportunities can be found.

Previous literature: Food waste market study

Last year Dr2 Consultants conducted a market study on the food waste management situation in the Yangtze River Delta. The market study was commissioned by the Dutch Rijksdienst voor Ondernemend Nederland (RVO) and the Consulate-General of the Netherlands in Shanghai with the aim of finding business opportunities for the Dutch food waste management sector. Click [here](#) to download the report.

Important findings of the food waste market study

The food waste market study was focused on post-consumption food waste, as urbanization and economic development influence the composition of food waste. Both China and The Netherlands are developing techniques to turn the food waste into energy or products of higher value. It is indicated **that China's consumption habits are changing** due to its urbanization and economic development. Expected - but hard to predict - changes in food waste composition suggest that a variety of technologies for waste separation and sorting will to be needed for adequate processing. This is especially relevant because different regions and provinces in China are in different stages of food waste management development. Better separation and sorting habits and techniques allow for more sophisticated treatment techniques. The Netherlands has implemented highly diversified waste collection and processing systems, so a variety of solutions could be offered from the Dutch side. The results concluded that there are opportunities for foreign expertise in advanced sorting and collection of waste, innovative incineration techniques, animal feed and composting for example but also in terms of innovative ways to deal with prevention in the longer term.

Though the market study was mostly focused on the food waste from household waste, it is also important to look at the food waste streams from the food processing industry. For example, the remains after processing fruit and vegetables, the remains of potato, unused cuts of meat, waste from dairy production, etc. This is known as industrial food waste.

¹ [How is China Feeding its Population of 1.4 billion?](#)

² [Food Conservation Action Plan](#)

³ [China's food industry continues steady profit growth](#)

In the recent 6 years, from the almost 350 Mt of food annually produced for human consumption in the country, 27% percent is lost or wasted, where 45% of this is associated to postharvest handling and storage⁴. As these are pre-consumer food waste streams, they can serve as high quality inputs for animal nutrition because of their high nutritional value.

Research questions

In order to structure the food processing industry and its waste streams, the main questions include the following:

What are the main categories in the food processing industry that can be identified, what is their current status in terms of food waste streams and their stakeholders?

Are there any potential limitations, future opportunities and/or trends in food waste management that could indicate business opportunities (especially for Dutch parties)

3. Methodology

Desk research is the basis of analysis, used as a background to plot the field research for reliability and representativeness. Through the combined networks and research expertise, the project team has access to local, national, and international resources on the academic-, government-, association- and private sector level. Information or data on the quantity of food waste and loss that occurs during the processing of food is often fragmented and/or incomplete. The examples used in this quick scan contain information and data from existing literature, informed information from experts, and other publicly available information.

Definitions

Food waste within the scope of this quick scan is defined as the food waste that comes from food manufacturing and processing; it consists of the generated waste during the trimming of edible parts, for example skin, fat, crusts and peels from food. Some of this waste is recovered for other purposes such as input for by-products or animal feed and some of this is disposed as waste. In general, there are several factors that contribute to waste streams; for example, overproduction, product damage, and technical problems at manufacturing and processing facilities.

Geographical focus

The national government in China has appointed the YRD region as a demonstration zone for promoting integrated eco-friendly development. Not coincidentally, the region is home to three of eleven zero-waste pilot cities under the zero-waste cities pilot program by the Chinese Ministry of Ecology and Environment. Major companies which have influenced consumption behavior in China, such as Alibaba, HeMa, and Ele.me also have their roots in this region. In addition, the area is subject to a fast urbanization rate in general but has different characteristics in terms of city scales, economic development, incomes, and food waste per capita. Its defining characteristics can be applied to other areas and cities in China. Agriculture production systems in the YRD are contributing considerably to the **country's quest** for food security⁵.

⁴ [China's food loss and waste embodies increasing environmental impacts](#)

⁵ [Challenges and strategies for agricultural green development in the Yangtze River Basin](#)

The YRD's affluence, high population density, sound infrastructure, and easy access to seaports all contribute to the prosperity of its food processing industry. Its strength is in dairy products, meat products, seafood products, snack foods, baby foods, instant noodles, health foods, and drinks & beverages. Many famous domestic brands of packaged food and beverage products were created in this region, some as a State-Owned Enterprise (SEO). It also hosts the branches of many famous multinational food processors, such as Mars, **Mondelēz International**, **General Mills**, **Nestlé**, **PepsiCo**, **Cargill**, and Group Danone. Shanghai, Nanjing, Kunshan, Wuxi, and Suzhou of Jiangsu Province, along with Hangzhou and Ningbo of Zhejiang Province, hosts numerous domestic and international food & beverage processors⁶.

The food sector in the Zhejiang Province has been undergoing significant developments with a focus on modernized large enterprises, new policies, and strengthening of food safety management. It has a highly developed farming and food processing industry and recently started focusing on developing **organic farming**. With Zhejiang's coastline occupying more than 20% of the entire Chinese coastline, the fishing industry is of great importance and the Zhoushan Archipelago is the largest area for sea fishery in China. Livestock farms in the area are usually small-scale family operations with poultry, pigs, cattle, and sheep⁷.

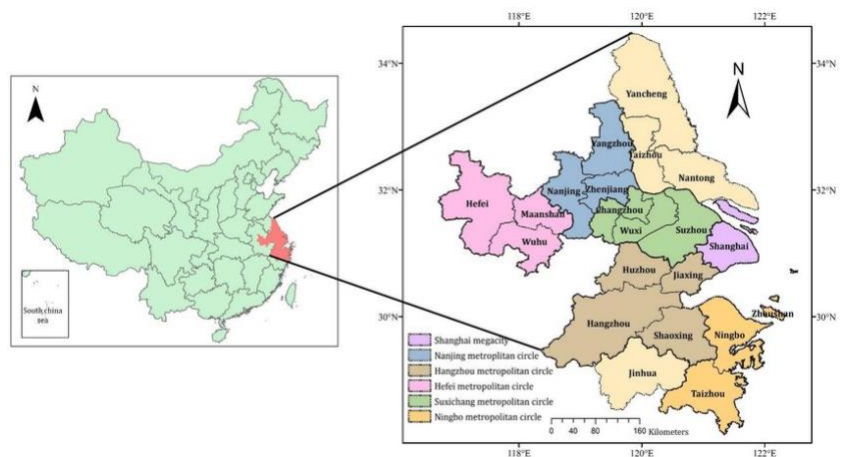


Figure 1. Map of the Yangtze River Delta

To get a better sense of the food processing industry and its waste streams in the YRD area, this quick scan will focus on illustrating the following major food categories: grains, meat & aquaculture, and vegetable & fruits. For more detailed information about the Yangtze River Delta, please refer to the food waste market study mentioned before.

⁶ [China's Food Processing Annual Report](#)

⁷ [Recent agriculture in the Yangtze River Delta](#)

4. Major food groups in China & YRD

This section will highlight the following food categories that are chosen because of their significance in terms of production volumes and their importance in the Yangtze River Delta: grains, vegetables & fruit, meat, and aquaculture. These are further described below with more specific details.

Grains

Last year China's total grain production reached 685 billion kg, hitting a new record high, according to data from the National Bureau of Statistics (NBS). This number has remained stable in recent years, providing a strong food security foundation. Because **China's food supply** depends largely on staple foods such as rice, wheat, and maize, most of the existing literature will indicate these staple foods as liangshi (grain). Grains and oil-bearing crops are grown and processed almost everywhere around the Jiangsu province. China is a big producer and consumer of rice. The Yangtze River Delta is the best-known homeland of wet-rice agriculture and processing.

Vegetables & Fruit

China's annual vegetable production has been maintained at around 700 million tonnes during the 13th Five-Year Plan (2016-2020) period, and fruit production at around 180 million tonnes, said the **country's Ministry of Agriculture and Rural Affairs**. Vegetables are an important non-staple food in China. The vegetable industry also provides raw material for the food-processing industry. The production value of the vegetable industry accounts for more than 10% of the total agricultural production value. In addition, many fruits such as peach, Asian pear, apricot, plum, jujube, chestnut and filbert are native to China. The Yangtze River Delta houses numerous lakes and rivers that deliver fertile soils and stimulates the agricultural production that feed the food processing industry. There are more than 260 types of fruit trees, tea plants, mulberry trees and flowers, and more than 1000 kinds of vegetables. Jiangsu is also famous for its silkworm rearing and green tea production and processing.

Aquaculture

At more than 66.1 million tonnes in 2018, China's aquaculture production accounted for an impressive 58 percent of global output. This inland production occurs primarily within the valleys between the Yangtze and Pearl Rivers, which offers ample access to water sources. Jiangsu province is home to The Taihu Lake area with **abundant fish resources, over 140 freshwater fishes, it's** the major river crabs and young eels producing and processing regions in the country. Ningbo is the second largest city of Zhejiang and benefits from its coastal location and produces various kinds of processed seafood that are widely distributed throughout China.

Meat

The total China meat supply in 2022 is expected at 79 million tons, surpassing total meat supplies before the emergence of African swine fever (ASF). This is largely driven by pork production, which is now expected to grow for a second consecutive year. China has one of the most abundant livestock and poultry resources in the world. The average annual growth rate of output value of livestock and poultry industry reaches 13%, and the output value of livestock and poultry industry accounts for more than 35% of total agricultural output. The Yangtze River region is also one of the key pig-producing regions in the country. Jiangsu Province is very strong in meat products and snack foods processing.

Major developments

The Chinese food industry faces major changing factors in policy, economics, society and technology. The changing factors are driven largely by the rapid urbanization that the country has been undergoing and still is undergoing.

As preferences and behavior in food consumption are changing, China is becoming more dependent on food imports. This food trade deficit in recent years together with the implications of international trade due to the pandemic has made China increasingly aware of the importance of self-sufficiency for a sustainable food supply. However, it is complicated by the reality that poor and fragmented regulation has caused significant environmental damage, which greatly limits domestic production and processing capacity⁸. Increasing domestic production and processing brings additional challenges in terms of food waste and loss. The Chinese central government made major revisions to the national Food

⁸ [How is China Feeding its Population of 1.4 billion?](#)

Safety Law in 2015 to tighten food safety regulations and strengthen enforcement⁹. Also, more recently the Food Conservation Action Plan¹⁰ has been issued to reduce loss and effective utilization of by-products from grain production and processing.

Because the population is developing, awareness of societal issues is making a shift as well. The majority of people have been lifted from extreme poverty, shifting their focus towards the future. With the increasing awareness of food safety and healthy food needs, Chinese consumers are also becoming increasingly aware of the negative implications of food waste and loss.

These changing factors will bring the challenge of effectively dealing with the waste streams of food production and processing. Bringing these waste streams to higher levels where it can be reused in the food supply chain or effectively prevented are the most preferred options as illustrated the Food Recovery Hierarchy in Figure 2.

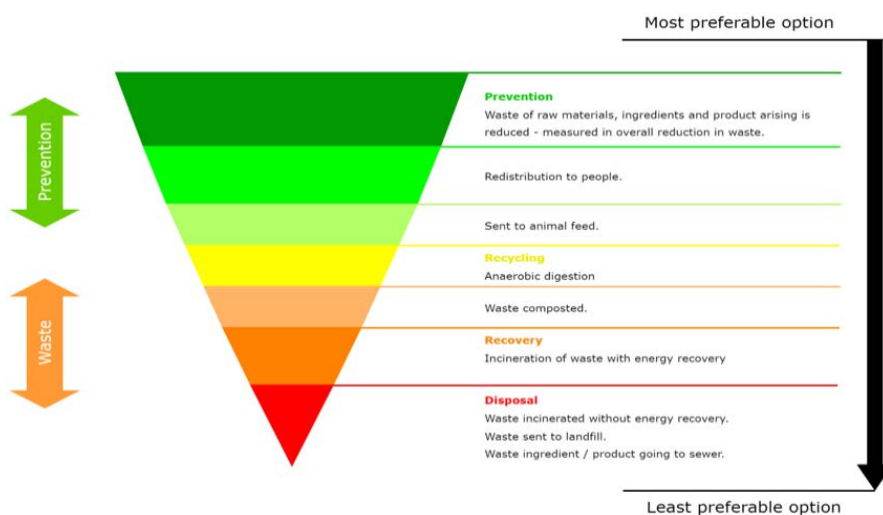


Figure 2. Food Recovery Hierarchy

a. Waste streams

From the previous food waste market study, it already became clear that China is transitioning up from the least preferable option, using landfills, to more preferred options when dealing with household food waste or post-consumer food waste. As pre-consumer food waste from production and processing usually involve biological waste of higher nutritional value, it can serve as better quality input for the more preferred options depicted in the Food Recovery Hierarchy. From the discussions with experts during this quick scan it is important to note that in China these particular waste streams were often dealt with through informal processes. For example, local farmers would collect food waste from processing facilities to use as livestock feed, against a fee. However, this informal infrastructure is gradually being eliminated. Formal processes are increasingly set in place where businesses have to deal with collection companies that are usually regulated by local authorities. Unfortunately, from the existing literature, there is limited information about these processes and developments. As these are practical processes that will develop according to the changing policy landscape, there is a need for more transparency to map out the structure and eventually increase efficiencies and effectiveness.

The following section will provide information about certain waste streams from the food categories indicated before; grains, meat & aquaculture, and vegetables & fruit. It will give an overview of the waste from these categories that is produced during production and processing.

Grains

⁹ [Revisions national Food Safety Law](#)

¹⁰ [Food Conservation Action Plan](#)

Because China's food supply depends largely on staple foods such as rice, wheat, and maize, most of the existing literature on postharvest food losses and waste concentrate on liangshi (grain). Post-harvest waste happens due to poor storage facilities, inefficient transportation, and bad packaging standards. The majority of grain losses and waste are found in postharvest handling (4-6% on average) and storage (5.7-8.6% on average). In processing and distribution, the average loss of grain is 2.2-3.3% and 1-1.5%, respectively¹¹. Historically, most grain waste will be used as livestock feed.

Rice

China's rice production is extremely rich, the annual sown area takes up 30% of the total grain planting area, 44% of the total grain production. And every year the process produces 40 million tons of rice husk, more than 30 million tons of broken rice, more than 14 million tons of rice bran, and other valuable by-products.¹²

According to data from the Ministry of Agriculture, the annual loss in the processing stage was more than 7.5 million tons¹³ in 2015. The Rice Sub-association of China Food Industry Association estimates that if the market share of refined rice continues to rise, annual rice loss would be as high as 20 million tons, enough to feed 130 million people¹⁴. To meet the demand for greatly improved living standards in China, most rice processors polish rice twice, or even more times, to increase its commercial value. The over-processing not only reduces output rate and increases the cost for rice processors, but also deteriorates the nutritional value of rice.

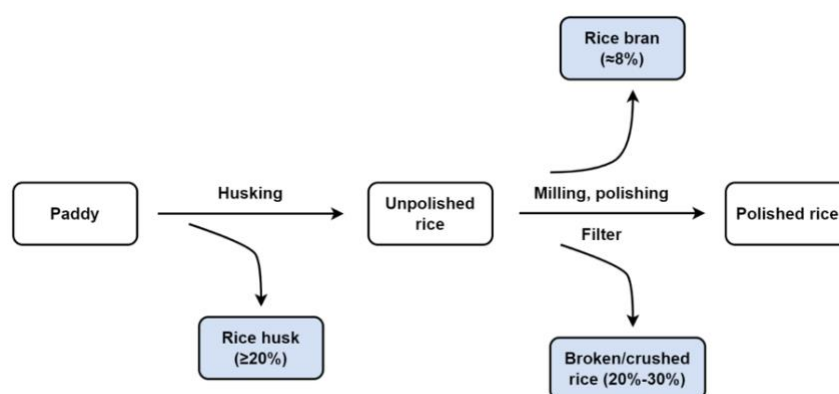


Figure 3. Types of rice by-products (indicated in the blue boxes)

There are mainly 3 types of rice by-products as illustrated in above Figure 3:

Rice husk is used in fuel and other low-value industries, and most of rice husk is directly discarded or incinerated. Recent studies show that rice husk has great application potential in the preparation of bioethanol, biobutanol, activated carbon and adsorbent.

Rice bran is rich in nutrients, including protein, fat, polysaccharide, dietary fiber, phenols, sterols, squalene and other active ingredients. The fat content of rice bran is about 16%-20%, and the rice bran oil can be extracted by pressing/solvent extraction, and the unsaturated fatty acid is up to 80%. The protein content of rice bran is about 8.5%-10%, which can be used to extract rice protein. The defatted or stabilized rice bran can be treated by fermentation and used as excellent food base material.

¹¹ [Food Losses and Food Waste in China](#)

¹² [Discussion on comprehensive utilization technology of broken rice\(碎米综合利用技术探讨\)](#).

¹³ [Tackling the Food Waste Crisis in China](#)

¹⁴ [Reduction of food loss and waste urgent in China](#)

Broken rice mainly includes cortex, endosperm and embryo, which are rich in starch. It can be used as raw material to produce porous starch, resistant starch and fat substitute is a good way to turn waste as ingredients. Broken rice can also be used to develop rice bread, rice flour, reconstituted rice, etc. In addition, the water extract of broken rice is rich in nutrition and can be used for processing and making drinks.

Every year, 40 million tons of rice husk and more than 14 million tons of rice bran and other valuable by-products from rice processing have not been effectively developed and utilized. They are usually used for low value-added purposes such as feed and fuel, or even directly discarded or incinerated, resulting in resource waste and environmental pollution.¹⁵

Soybeans

Because of the strong growth in food consumption, it has also increased the consumption of soybean oil and soybean meals drastically. China’s soybean consumption reached 11.85 million tons in 2020¹⁶. **Most oil crushing plants are located along China’s east coast, accounting for 80 percent of China’s total crushing plant capacity.**

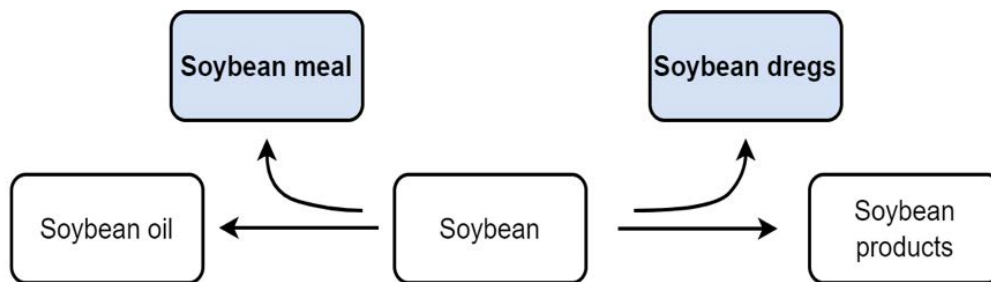


Figure 4. Types of soybean by-products (indicated in the blue boxes)

In China, there are two main forms of comprehensive utilization of soybean oil pressing by-products. One is the utilization of soybean meal after soybean oil extraction for animal feed, and the other is the full utilization of soybean dregs after soybean is processed into food.

Soybean meal output in 2019 was 74 million tons. Concentrated protein, protein isolate, low denaturation defatted soybean powder, dietary fiber, protein peptide, compound amino acids, saponins, oligosaccharides, etc. can be obtained from soybean meal. Soybean meal is also a key ingredient for feed, due to its good amino acid composition. About 85% of the meal is used in poultry production. Soybean meal is also seen as a co-product of soybean oil production.

Soybean dregs is the largest by-product of soybean processing (15% ~ 20% of the total dry weight of soybean) for the production of for example tofu and soya milk. Annually 20 million tons of wet soybean dregs are produced. As the production process includes the addition of water, the moisture content of wet bean dregs is between 78% and 85%, which causes the wet bean dregs to be very heavy. Because the moisture content is large, transportation is difficult and easy to rot, it is difficult to process soybean dregs. The high cost of drying soybean dregs hinders the comprehensive utilization of soybean dregs.

¹⁵ [Current Status and Prospect of Appropriate Processing of Rice and Comprehensive Utilization of By-products\(大米适度加工和副产物综合利用现状及展望\)](#).

¹⁶ [Huaon.com](#)

Meat & Aquaculture

The loss rate at postharvest handling, storage, processing, and distribution stages of meats can be approximated as 1.4-2.1%, 2.5-3.7%, 1.1%, and 3%, respectively. The pork industry accounts for **65% of China's domestic meat consumption, and produces 1.29 billion metric tons of waste every year**¹⁷. It is estimated by the OECD that about 2%, 4%, and 3.2% of fish and aquatic products are lost at the harvesting, storage, and distribution stages, respectively¹⁸.

Fish

During fish processing, a large number of byproducts (including fish heads, fish skins, fish bones, fish scales, and viscera) is produced, which constitutes approximately 40-55% of a raw fish. The effective use of byproducts has a direct influence on China's economic and environmental pollution. Fish protein is expected to play an important role in China's food security and waste can be processed into fishmeal for fish feed¹⁹. The nonuse or underutilization of byproducts not only leads to loss of potential revenue, but also results into an increase in these products and their disposal costs²⁰.

The byproducts of freshwater fish are more than 2.5 million tons per annum, most of which are not used, usually due to the fact that they have little of low economic value²¹. A large number of leftovers will be produced during seafood processing, and the leftovers discarded during fish processing account for 40% - 50% of raw fish. It is rich in fat, protein and minerals. The leftovers will usually be discarded or discharged into nearby waters²², resulting in a great waste of resources and environmental pollution. For example, the protein content of silver carp residue is 14%, and the oil content is 9.22%; Eel waste is also rich in egg fat, chondroitin, vitamins, protein and so on. The internal organs of squid contain 20% - 30% crude fat, 86% unsaturated fatty acid, 12% EPA and 24% DHA. The protein content of shrimp waste is 15%²³.

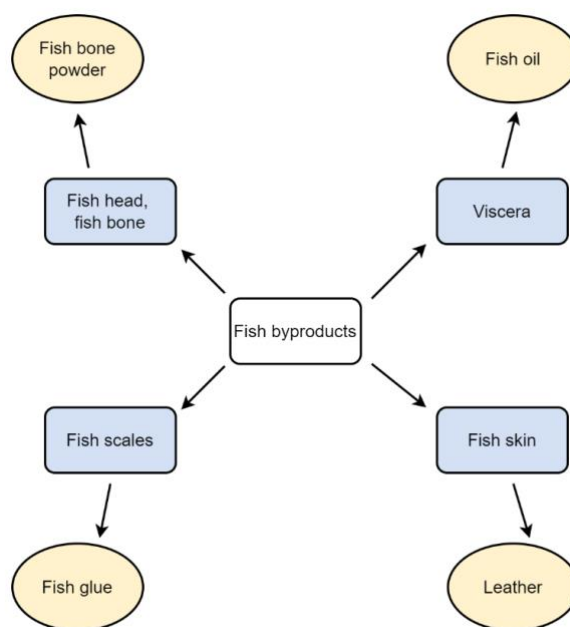


Figure 5. Types of fish by-products (indicated in the blue boxes)

Vegetables & fruit

In China, fruit and vegetable waste accounts for 20% and 50% of the total municipal solid waste, and the annual output of fruit and vegetable waste accounts for 25% - 30% of the total output of fruits and vegetables. About 100 billion tons of fruit and vegetable waste is discarded every year²⁴. Because of its high moisture content, fruit and vegetable waste is not suitable for the incineration processes. But due to the high content of organic

¹⁷ [The environmental effects of China's growing Pork Industry](#)

¹⁸ [Food Losses and Food Waste in China](#)

¹⁹ [Use of food waste, fish waste and food processing waste for China's aquaculture industry: Needs and challenge](#)

²⁰ [Novel technologies in utilization of byproducts of animal food processing: a review](#)

²¹ [Waste in aquaculture](#)

²² [Chinese aquaculture can tip the balance in world fish supplies](#)

²³ [Preparation of Meat flavors by Waste of seafood by Hydrolysis with Protease \(海产品下脚料酶解液制备肉味香精\)](#)

²⁴ [Research Progress on Comprehensive Utilization of Fruit And Vegetable Waste](#)

components, a large number of leachates will be produced by stacking or landfilling, which results in serious environmental pollution.

From seedling raising to maturity, from harvest to listing, and then to processing, every link will produce waste. In storage and distribution, the average loss of fruits and vegetables is estimated as 15% and 10%, respectively²⁵. The main sources of fruit and vegetable waste are fruit and vegetable production area distribution center and processing facilities. According to statistics, 1.2 million tons of vegetable waste are generated every year in 53.300 hectares of facility vegetable base in Shouguang area, Shandong Province. In the peak season of vegetable production and sales in May and October of each year, the daily output of vegetable garbage in Beijing Xinfadi Agricultural products Wholesale Market is about 180 tons, accounting for more than 90% of the total. During processing, the loss rate of leafy vegetables is the highest, with a loss rate peak around 60% in summer.

Current treatment of vegetables & fruit waste in China:

Anaerobic digestion: The results show that the water content of vegetable waste is high, it is easy to degrade, its chemical oxygen demand and nitrogen ratio are between the requirements of methane-producing microorganisms, and the anaerobic digestion is especially suitable for the treatment of vegetable waste

Anaerobic fermentation technology: Aerobic composting includes direct composting of fruit and vegetable waste and mixed landfill of fruit and vegetable waste

Feed protein: At present, the main feeding methods are silage, processing feed protein and feed powder.

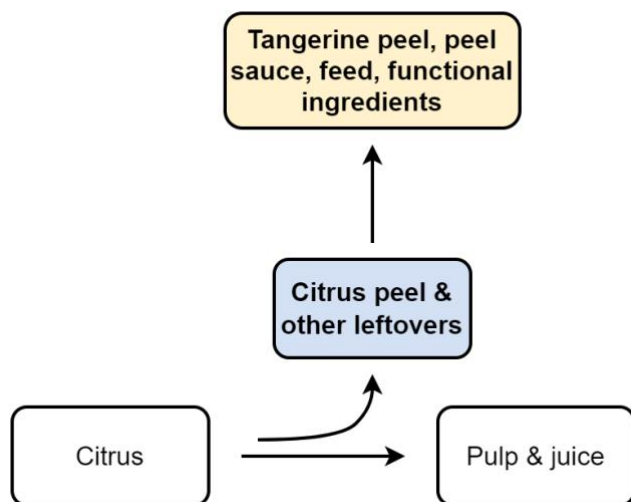
Quality adsorbents for sewage treatment: The results show that fruit and vegetable solid waste has good adsorption effect on hexavalent chromium ion, copper ion and methylene blue, which can be used as pretreatment of industrial wastewater treatment, which can greatly reduce the burden of subsequent sewage treatment.

Citrus

China processes more than 5 million tons of oranges every year, producing about 2 million tons of peel and fruit residue. In addition, more than 5 million tons of defective fruits and surplus fruits are directly treated as waste through landfilling and incineration²⁶. Citrus peel is used to extract essential oils or produce ethanol fuel and feed for example. Most of them are treated as waste, which not only causes great waste of resources, but also pollutes the environment.

²⁵ [Food Losses and Food Waste in China](#)

²⁶ [Current situation and Countermeasures of resource utilization of citrus waste in Jiangxi Province\(江西柑桔废弃物资源化利用现状与对策分析\)](#).



In the early stage of the development of animal husbandry in China, the vegetable waste of the rural households is often directly fed to animals such as pigs, sheep and chickens, which plays an important role in the development of animal husbandry in China at that time. However, in the process of direct feeding, the combination of lignin and sugar in fruit and vegetable waste will increase the difficulty of decomposing microorganisms and enzymes in rumen of animals, and direct feeding cannot be absorbed and utilized by animals efficiently. In addition, the direct raising of livestock and poultry with pests and

diseases may endanger animal health.

b. Stakeholder overview

In terms of food manufacturing and processing companies that can be seen as the food waste producer within the scope of this quick scan, it is challenging to find relevant data that can show the amounts of food waste generated from their processes. From the field research, it also shows that it can be a sensitive area. Depending on the food category, it is assumed that China has been regulating the waste monitoring and processing procedures increasingly in recent years. For example, Royal Friesland Campina indicated that for their different product categories (baby milk powder, milk tea components, and unprocessed ingredients) it currently has a system in which it identifies the amount and type of waste. This in turn can be processed by scrap facilities, animal feed facilities, or wastewater treatment. Another example, Aden Group, active in waste management as well as industrial catering, mentioned that in recent years the management of waste has changed tremendously. Whereas before it was common practice to sell biological waste directly to farmers, it now gets collected by collection companies that are usually regulated by local authorities, against payment.

Major local food production and processing companies

There is limited information available about the waste streams of food production and processing companies with regards to its numbers and how it is structured. However, considering the state-owned nature and size of certain players it is interesting to highlight.

Bright Food Group is a Chinese food industry group involved in agriculture, food processing, and manufacturing, as well as retailing. It is involved in diverse business areas, but its main food businesses include packaged foods, dairy, sugar and vegetables. Its dairy business has more than 10 pastures with 12,000 cows and a 500,000-ton annual production capacity. Although there is limited information available about their waste streams, considering Bright Food Group is one of the largest State-Owned Enterprises in the food processing industry, their impact will be considerable.

COFCO Group is China's largest food processor, manufacturer and trader. The company provides products covering all the main categories of daily consumption (including grains, oil seeds, and sugar products) in China with an annual processing capacity of over 60 million tons. Although there is limited information about the food loss and waste coming from their processes, they do indicate their focus on food security and a circular economy through waste management practices. Their international experience and knowledge in this can be highlighted by creating green energy through 4 million tons of sugarcane

Relevant (Dutch) waste management and feed companies

This section will highlight certain companies that are active in the waste management sector and focuses on animal nutrition. A special interest is given to certain companies with Dutch origins, to indicate successful business cases of international collaboration in these sectors.

Agrifirm is a Dutch company focusing on the arable and livestock feed sector and their most important market is China. The young animal feeds are produced in two factories, one of which was newly built in 2015. Premixes and concentrates are an important focus, often dealing with larger pig farms with 1,000 to 50,000 sows. In addition, since their joint venture with Land O'Lakes in 2020, Agrifirm's activities in the Chinese cattle farming sector have grown.

De Heus is a Dutch company focuses on animal nutrition. Besides delivering high quality feeds, they also offer in-depth knowledge about nutrition, animal health, animal husbandry and animal farming, to achieve efficiency and to make technological progress. To improve the ecological footprint, part of TRUST FEED, the quality control system the Dutch feed industry has developed. In addition, it has established a successful joint venture with Wellhope, a leading feed producer in China. Together they established the development of a pig slaughtering and processing plant. This is probably one of the Dutch company's most successful investments because the initial investment has increased tenfold to nearly 1.5 billion yuan in 10 years.

Hyva is an environmental protection technology focusing on waste management solutions and equipment in China. With origins from the Netherlands and extensive expertise in hydraulics and transportation. Interestingly their expertise in dealing with food waste management has its roots in China.

Trouw Nutrition is a Nutreco company from the Netherlands. With more than 10 years development in China, Trouw Nutrition China's main business includes farm minerals, vitamin blends, premix, young animal feeds, feed additives and animal health products as well as related nutritional services to the animal nutrition industry.

Administrative authorities

The national administrative authorities will of course have their influence when it comes to forming the regulatory frameworks. As indicated by the food waste market study, on the national level the Chinese Ministry of Ecology and Environment (MEE) and Ministry of Agriculture and Rural affairs (MARA) will be relevant when it comes to the utilization of waste products, for example animal feed and nutrition.

Implementation will happen on a more local level & industry associations will have strong local government involvement. To find effective management solutions for different areas, there have been over 100 pilot cities appointed since 2010 to explore alternative waste management systems including projects focusing on food waste valorization. These pilot cities were decided upon by four ministries: the Chinese National Development and Reform Commission, the Ministry of Housing and Urban-Rural Development, Ministry of Ecology and Environment and Ministry of Agriculture and Rural affairs.

From a more practical view, the field research indicates that local governments have a strong role in how food production & processing companies deal with their waste. For example, the amount of waste and composition needs to be registered and paid for. Certain waste would be suitable for scrap facilities (baby milk powder after passed expiration date), whereas other waste would be suitable for animal feed facilities. However, there is less transparency on the exact structure of these processes. For a more detailed list of the relevant stakeholders described in the above section please refer to the annex.

c. Policy and regulations overview food waste utilization

For a better understanding of how the relevant stakeholders operate, an analysis regarding relevant policies for the food production and processing industry is needed. The regulations or rather guidelines for food production & processing and how they can deal with their waste streams. Food producers and operators should engage in production and business activities by laws, regulations, and food safety standards, while the food safety commission of the State Council should do the overall planning and provide guidance on food safety.

The health administrative departments above the county level establishes a food safety risk monitoring and consultation mechanism, working with food safety supervision and management departments. The State Council's administrative department for public health formulates national food safety standards and its annual implementation plan with other related departments. Food production and operation licenses are valid for five years. It also states that catalogs of new food raw materials, new varieties of additives, and food-related products should be made public promptly. The decree also mentioned the rules on food inspection, import and export, management of food safety accidents, and the supervision of food safety. It also included details of punishment for any food safety violations²⁷.

As indicated in the food waste market study, policies and regulations regarding food waste are still fragmented. There is a general sentiment to reduce food waste and the central government has indicated a top-down approach in their overall plans. Recent years have seen a strong focus on waste management in general, specifically for household waste. The implementation of food waste management practices depends on several important factors, **such as the city's statutes, environmental requirements, strategies in environmental management, energy policies, economic standing, technological capabilities, education, and environmental awareness of its citizens.** Different cities prioritize waste reduction, treatment, or final disposal based on local needs. Overall, throughout China, the lack of data collection and transparency on food waste flow, especially in the food processing industry, undermines good governance and practices. This allows food waste to easily be unreported at any stage of the food supply chain and routed from treatment facilities to cheaper options such as illegal landfills. As stated previously, the expanding war on pollution could soon lead to stricter food waste reporting requirements, as has been the case with air emissions²⁸. As food waste recycling, valorization, and the reuse of food waste streams are in its early stages of development, the policies and regulations are also not quite as clear cut when it comes to specific industries yet, for example, the food production and processing industry. The implications can be somewhat on a case-by-case basis.

In November 2021, the Food Conservation Action Plan²⁹ was issued, which has implications for the grain production and processing industry. In this plan, the importance of food security is emphasized again, with increased focus on reducing & saving harvest, storage, transportation, and processing losses. In addition, also more focus will be on the effective utilization of grain and oil processing by-products such as rice bran, bran, germ, oil meal, potato residue, and potato liquid to produce edible products, functional substances, and industrial products³⁰. Using food residue as feed for livestock or poultry is a very normal procedure in China. However, this is not always stimulated by policies due to concerns of bacterial contamination and epidemic diseases. Stricter laws have been implemented since 2006, spurring new experiments such as those with fly maggots (black soldier flies) to treat food waste. The cultivation of these insects can be implemented for the treatment of food

²⁷ [The State Council PRC](#)

²⁸ [From Farm to Table to Energy](#)

²⁹ [Food Conservation Action Plan](#)

³⁰ [Food Conservation Action Plan](#)

waste streams, which will result in higher quality food waste which in turn can be used for animal feed. Please refer to the annex for an overview of policies, regulations, guidelines, and plans regarding food manufacturing and processing, food waste treatment, and animal feed.

d. Society & technology

The rapid development and urbanization rate in China create challenges because habits and preferences are also changing. The growing middle class and technology developments in society have influenced the fast-consuming lifestyle, especially among the younger generation. Together with an increasing focus on health, the demand for healthy (processed) foods and snacks is increasing as well. Because of more wealth, where most of the population has been lifted from extreme poverty, focusing on a sustainable future will become more important. Where the importance of food safety and resource scarcity will become increasingly apparent, it will influence the development of how to deal with food loss and waste. Increasing investments and developments in modern techniques to cope with food loss and waste can offer opportunities for international companies. Examples of these developments can be found where the producer of food waste pay the bill, the increased focus on resource recovery, and food waste prevention.

Previously food waste could be handled in informal ways directly with farmers or other companies in need of biological waste and money could be earned. Now companies are regulated to use the official waste collection companies and have to pay based on the amount of food waste. In Shanghai for example there are about 90 collection companies responsible for district-specific collection and transportation of food waste. To ensure that the management of food waste is economically viable, municipal governments often charge business operators fees for food waste disposal to subsidize the operation of municipal food waste treatment plants.

The top-down approach of the central government in their overall plans to reduce food waste can be illustrated by the process of transitioning away from using landfills and incineration. China identified 100 first- to third-tier cities to carry out pilot projects to maximize the resource recovery from urban food waste. Targeting projects in these areas has proven beneficial to many cities. By the end of 2017, approximately 87 food waste processing facilities were in operation. The main technologies they are using are anaerobic digestion and aerobic composting. The region also sees increasing facilities that focus on animal feed technologies. This has given opportunities for technology and hardware innovations that can (pre-)treat food waste in order to reduce the amount and/or prepare for further treatment.

The main challenge is that business models need to be created to implement certain new technologies and techniques. Especially for food production and processing companies, increasing the efficiency and effectiveness of their business practices can lead to lower costs in terms of purchasing as well as dealing with food loss and waste. In the food production and processing phases, the focus on mechanized harvesting, the strict implementation of standards, mechanized harvesting technology, and operation specifications, as well as strengthening the professional qualification management and training of agricultural machinery operators, and encouraging farmland merger, grain green storage technology, energy-efficient drying technology, regional grain logistics management, and other measures can effectively reduce grain loss. China has gradually established a relatively comprehensive system of laws and regulations in terms of grain loss, combined with awareness-raising activities to ensure the effectiveness and implementation of policies

related to food loss reduction. The most recent implementation can be seen from the Food Conservation Action Plan³¹.

5. Conclusion

From the existing literature and data, it becomes apparent that the available information regarding the waste streams of the food production and processing industry is quite fragmented and incomplete. One of the underlying issues is the rapid developments China is undergoing where proper data collection and transparent reporting and monitoring can still be lacking. In addition, policies and regulations are also subject to ongoing developments in this regard. There are a lot of improvements to be made in this particular segment when it comes to analyzing these waste streams.

Based on the literature review and the discussions with experts in the field, this quick scan can provide an overview of certain food categories. As by-products in food production and processing can be comparable to a certain extent no matter the location, the analysis focuses on to what extent these streams are utilized. It also provides interesting insights concerning potential opportunities in this area.

a. Opportunities based on the policies and regulations

The sustainable supply of food for China's 1.4 billion people is balanced with a focus on increasing food production and processing as well as dealing effectively with the food waste that occurs during the food supply chain, and eventually measures to help prevent it from occurring.

An initial opportunity that can be deduced are technologies that can be implemented for the proper registration of the food waste streams and the by-products that occur during food production and processing. As mentioned, with the rapid urbanization the YRD is dealing with, food shortages will become increasingly serious. Increasing production capacity inherently means that there is an increasing need for animal feed while also the waste streams from food production and processing will increase. To cope with this situation, China has made developments in the effective utilization of these side streams but considerable amounts are still being discarded as waste.

From the Food Conservation Action Plan, the underlying importance of food loss and waste prevention throughout the food supply chain can be deduced. This means that in the longer-term preventing waste from happening that occurs throughout food production and processing or reducing the amounts of waste in these waste streams will become increasingly relevant. Please find an overview of the food categories, the relevant information regarding their waste streams, and the potential opportunities in Table 1. on page 4.

³¹ [Food Conservation Action Plan](#)

Potential business chances for Dutch companies

All treatments of organic waste streams that upcycle these streams to new products (food/non-food) that Dutch technology has to offer, apply to the waste streams of the food processing industry. It is expected that this creates a better business case for the food processing industry and also makes this industry compliant with regulations now and in the future. The Dutch have extensive experience in developing technologies that can make a profitable business case through a circular economy. The Netherlands is a huge agricultural exporter, **generating €94.5 billion for the Dutch economy in 2020**³², focusing on creating a sustainable industry. It can be said that the industry is quite self-sufficient when it comes to feeding its livestock, using food waste or discarded foodstuffs as animal feed.

What this quick scan shows is that there is a huge potential for organic material, on top of the amount the Food Waste study pointed out. Bringing these streams to a higher level, as depicted in the food recovery hierarchy, is a big chance for both the circular performance of China and the circular technologies of Dutch companies. Table 1. indicated the overview of certain challenges and opportunities that can be relevant.

The innovative knowledge, experience, and techniques are present in The Netherlands with regards to animal feed, which means there are a lot of relevant companies active in this sector. From the expert discussions, it does become apparent that sourcing for the sustainable supply of pre-consumer food waste can be a challenge in China. All the food taken for processing into animal feed is pre-consumer, which means it is sourced directly from food producers and processors.

Especially when it comes to dealing with fish, vegetable, and fruit loss and waste, there is a huge potential as currently it mostly gets discarded or treated as waste which has a tremendous negative impact on the environment. Upcycling liquid waste streams technologies can be a potential opportunity to explore. When effectively utilized for the use of feeding livestock, it can help with the development of a more self-sufficient food chain.

³² [Farming for the future: why the Netherlands is the 2nd largest food exporter in the world](#)

6. Appendix

Stakeholder list

Please note that the stakeholder list consists of the prior contacts, desk research, and other considerations from both Dr2 Consultants and the RVO/Dutch Embassy.

Food producer / processor

Chinese name	Company	Category
金龙鱼	Jinlongyu	Agricultural products
伊利股份	Yili	Dairy products
蒙牛乳业	Mengniu Dairy	Dairy products
天润乳业	Terun	Dairy products
双汇发展	Shineway	Meat products
圣农集团	Sunner	Meat products
新希望六合	New Hope Liuhe	Meat products
达利食品	Dali Food	Comprehensive food products
绝味食品	Juewei Food	Comprehensive food products
克明面业	KM Noodles	Flour products
光明食品	Bright Food	Comprehensive food products
中粮集团	COFCO	Comprehensive food products

Food waste valorization

Company	Expertise/field
Guangzhou Unique Biotechnology	Animal feed
Protix	Animal feed
COFCO	Animal food
Fengcheng (Shanghai) Food Recycle	Food recycling & processing
AgriFirm	Animal nutrition
De Heus	Animal nutrition
Nutreco	Animal nutrition
Zhengda Group	Animal food
New Hope Liuhe	Animal food
Beijing DBN	Animal food

Food waste processor

Company	Expertise/field
Hyva	Environmental protections technology and hardware
WTT	Integrated treatment of organic waste
China Tianying	WTE, biomass treatment
Sien-sol	Integrated treatment of organic waste
Nanda	Food waste processing recycling

Association

Chinese name	English name	Website
中国循环经济协会	China Circular Economy Association	https://chinacace.org/
中国食品工业协会	China National Food Industry Association	http://www.cnfia.cn/
中国焙烤食品糖制品工业协会	China Association of Bakery & Confectionery Industry	http://www.china-bakery.com.cn/

中国食品土畜进出口商会	China Chamber of Commerce of I/E of Foodstuffs, Native Produce and Animal By-products(CFNA)	http://www.cccfna.org.cn/
中国饲料工业协会	China Feed Industry Association	http://www.chinafeed.org.cn/

Government(legislator)

Institution	Task(s)	Key policies / projects applicable
Embassy of the Kingdom of the Netherlands	Providing support for the Dutch BV in China	Invest in public/private internationalization projects
State Council	Financial guidance in projects with public-private partnerships	Opinions on Strengthening Gutter Oil Remediation and Food Waste Management (2010)
Ministry of Ecology and Environment (MEE)	Environmental standards and pollution control	Technical Requirements of Food Waste Resource Utilization (2012)
National Development and Reform Commission (NDRC)	Investment and funding	13th FYP Targets for 2020 (2016) 14th FYP Targets for 2025 (2021 - to be released)
General Administration of Customs (GACC)	Residual products of food waste management and processing	Saving Food and Reducing Food Losses among Foodstuffs and Oil-processing Industries (2014)
Ministry of Agriculture and Rural affairs (MARA)	Livestock related waste and feedstock utilization	The Soil Pollution Prevention and Control Law (2019)
Ministry of Housing and Urban-Rural Development (MoHURD)	Green urbanization policies	Compulsory Waste Classification System (2016)
National Medical Products Administration (NMPA) formerly China Food and Drug Administration (CFDA)	Food safety and public health issues	Food Safety Law
Ministry of Commerce (MOFCOM)	Stimulating economic development, including foreign investment	Food waste management fact-finding abroad

Policy overview

Food production and processing

- Measures for the administration of food Production Licensing
- Measures for the administration of Food Marketing Licenses
- Regulations for the implementation of food Safety Law of the People's Republic of China
- Measures for the administration of national standards for Food safety
- Interpretation of Administrative Measures on Safety of Import and Export Food **of the People's Republic of China**
- Administrative Measures for Food Safety Sampling Inspection
- GB/T 27320-2010 Food Defense Plan and Guidelines for Its Application Food Processing Enterprises
- GB15193.1-2014 National Food Safety Standard Procedures for Toxicological Assessment of Food
- Water Pollutant Discharge Standard for Food Processing and Manufacturing Industry (Draft)

Food waste treatment

- [Administrative Rules on Municipal Solid Waste: Detailed regulations on municipal food waste clearance 2007/04/28 MHURD](#)
- [Food Security Law Regulations on safety issues of food waste treatment \(e.g., clause 28: recycled food waste not allowed for food production\) 2009/2/28 NPC](#)
- [Grain Law Specific clauses \(clause 33 in the draft\) to promote grain saving and combat food waste Draft for comment promulgated on 2012/02/21 NPC](#)

Animal nutrition guidelines

Feed material	Product Standard
General rules for natural plant as feed material	GB/T 19424-2018 GB/T 19424-2018

Hygienical standard for feeds	GB 13078-2017GB 13078-2017
Soybean meal	GB/T 19541-2017GB/T 19541-2017
Feed grade spirulina powder	GB/T 17243-1998GB/T 17243-1998
Feed grade DL - methionine	GB/T 17810-2009GB/T 17810-2009
Maize for feedstuffs	GB/T 17890-2008GB/T 17890-2008
Feed additive - 80% Riboflavin(vitamin B2) particle	GB/T 18632-2010GB/T 18632-2010
Feed additive - 10% 4, 4'-diketo- B -carotene(canthaxanthin)	GB/T 18970-2003GB/T 18970-2003

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