

# What do we know about THE FUTURE OF AGRICULTURE SYSTEMS IN CHINA?

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## Key messages

- Addressing the dual challenge of limited resources and a large population, China must prioritize sustainable agricultural practices to ensure food security and environmental sustainability.
- The shift toward a more nutritionally balanced diet by 2050 will not only improve public health but also significantly alter the demand patterns for various food commodities, increasing the need for strategic adjustments in agricultural production.
- Technological innovation in agriculture presents a critical solution to overcoming constraints of land and water, highlighting the importance of continued investment in research and development for sustainable growth.
- Future agricultural transformations will likely involve a move away from traditional small-scale farming toward more efficient and cooperative agricultural models, driven by rural demographic changes and the growth of socialized service organizations.

## RECENT TRENDS AND CHALLENGES

The transformation of China's agricultural system needs to be based on two fundamental realities. The first is that China is a large country with small-scale farmers (Ji et al. 2016; Yu 2012). China has 187 million farming households (NBS 2024). According to the data from the third agricultural census, small-scale farming households account for more than 98 percent of the total agricultural business entities, and the cultivated land area operated by small-scale farming households accounts for 70 percent of the total cultivated land area in China. The second reality is food security. There is an old saying in China: "The people are the foundation of a country, and food is the primary need of the people." The enormous food demand of China's population of more than 1.4 billion cannot be expected to be fully met by relying on the international market (Han 2020; Huang and Yang 2017). While the Food and Agriculture Organization of the United Nations' (FAO) definition of food security covers several dimensions, China's food security has mainly focused on grain self-sufficiency (Huang and Yang 2017). If food self-sufficiency cannot be guaranteed, China's national development may be hindered. As residents' consumption demand shifts from "eating enough" to "eating well" and "eating nutritiously and healthily," China needs to use its limited water and land resources to promote agricultural transformation in the direction of sufficient quantity, good quality, green ecology, high efficiency, and optimal structure of food production.

China's agricultural system currently faces numerous challenges that threaten its sustainability and food security, as follows.

**Resource constraints and a large population.** China faces significant resource constraints in agricultural land and water per capita compared with other major agricultural producers. Despite accounting for approximately 20 percent of the global population, China has only 9 percent of the world's arable land and 6 percent of its freshwater resources (FAO 2024). In 2021, China's arable land per capita was 0.08 hectares (ha), significantly lower than the world average of 0.18 ha and that of other major producers, such as the United States (0.47 ha), Australia (1.21 ha), and Brazil (0.27 ha) (FAO 2024). Moreover, the seven major grain-producing regions in north China, which contribute 50 percent of the total grain output,

have access to only 10.84 percent of the country's water resources. Depletion of groundwater in these regions due to irrigated agriculture exacerbates these resource constraints (China, Ministry of Water Resources 2022).

**Growing import dependence and risks.** These resource constraints are compounded by China's increasing import dependence, particularly for key commodities such as soybeans. In 2023, China's grain imports exceeded 159 million metric tons (MMT), reducing the self-sufficiency ratio to approximately 81 percent (GAC 2024; NBS 2024). Soybean imports, essential for animal feed, account for the bulk of these imports. Net grain imports in 2023 reached 159.3 MMT, a significant increase from 59.1 MMT in 2010, while the self-sufficiency rate dropped from 90.4 percent to 81.4 percent in the same years (GAC 2024; NBS 2024). Soybean imports in 2023 reached 99.4 MMT, with a self-sufficiency rate of only 17.3 percent (GAC 2024; NBS 2024). This import dependence creates vulnerabilities to geopolitical tensions and global supply chain disruptions, highlighting the insufficient risk resistance of the grain trade supply chain.

**Need for improved agricultural sustainability.** Intensive farming practices have taken a toll on China's already limited agricultural resources. Overuse of chemical fertilizers and pesticides is widespread, leading to the degradation of soil health. However, with the implementation of fertilizer reduction initiatives, China's fertilizer input intensity continues to decline. In 2021, the fertilizer input intensity in China was 166 kilograms (kg) per ha, significantly higher than the world average of 65 kg/ha, despite having decreased by 24 percent compared with 219 kg/ha in 2010 (FAO 2024). Agriculture is also a major contributor to greenhouse gas emissions, with crops accounting for 58.38 percent and livestock for 41.62 percent of agricultural CO<sub>2</sub> emissions in China in 2014 (CAAS 2023). Improving agricultural sustainability needs to be addressed to ensure the long-term viability of China's agricultural system.

**Climate change and natural disasters.** Climate change poses a significant threat to food production in China. The *People's Republic of China Third National Communication on Climate Change* shows that for each 1°C increase in temperature, yields of staple crops such as maize, wheat, and rice may decline by 7-8 percent in China. Meanwhile, climate warming has caused the overwintering boundaries of pests and diseases to shift northward by 1 to 3.5 latitudinal degrees, leading to an increase in their reproductive generations and thus potential crop damage.

**TABLE 1 Projections of China's grain supply and demand in 2030 by major institutions or researchers, in million metric tons**

| Product    | Item                | CAAS   | OECD-FAO | USDA | PRIMAFF | MARA   | Huang and Xie<br>PKU |
|------------|---------------------|--------|----------|------|---------|--------|----------------------|
| Paddy rice | Domestic production | 217.82 | 153*     |      | 150*    | 215.00 | 194                  |
|            | Total demand        | 221.29 | 156*     |      | 151*    | 215.88 | 197                  |
|            | Net imports         | 3.47   | 3*       | 3*   | 1*      | 0.88   | 3                    |
| Wheat      | Domestic production | 142.17 | 136      |      | 143*    | 145.41 | 127                  |
|            | Total demand        | 150.34 | 143      |      | 149*    | 150.82 | 130                  |
|            | Net imports         | 8.17   | 7        | 9    | 6*      | 5.41   | 3                    |
| Maize      | Domestic production | 321.35 | 297      |      | 309     | 315.01 | 271                  |
|            | Total demand        | 337.75 | 305      |      | 319     | 321.95 | 324                  |
|            | Net imports         | 16.40  | 8        | 20   | 10      | 6.94   | 54                   |
| Soybeans   | Domestic production | 35.51  | 21       |      | 22      | 33.44  | 19                   |
|            | Total demand        | 119.91 | 122      |      | 124     | 112.78 | 148                  |
|            | Net imports         | 84.40  | 101      | 127  | 102     | 79.34  | 129                  |

**Note:** \* indicates milled rice. CAAS = Chinese Academy of Agricultural Sciences; OECD-FAO = Organisation of Economic Co-operation and Development-Food and Agriculture Organization; USDA = United States Department of Agriculture; PRIMAFF = Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries; MARA = Ministry of Agriculture and Rural Affairs; PKU = Peking University.

**Dietary imbalances and nutrition transition.** China's traditional dietary structure and consumption habits are characterized by features such as frugality, small carbon footprint, diversity, and the use of locally available ingredients (CAAS 2024). As incomes rise, China faces the challenge of dietary imbalances driven by a nutrition transition (Fan, Yosef, and Pandya-Lorch 2020). Chinese diets are shifting in important ways from a health perspective, with an increasing proportion of calories coming from fat and oil, while traditional carbohydrates are being crowded out and the intake of some micronutrients is insufficient (Sheng et al. 2021). Compared with the standards in the *Chinese Dietary Reference Intakes Part 1: Macronutrients*, the proportion of energy supplied by carbohydrates was close to the minimum level of 50 percent, whereas the proportion of energy supplied by fat exceeded the recommended range.

## LATEST FORESIGHT RESEARCH

Forecasting China's future food security has been a research focus for both Chinese and international institutions, including the Organisation for Economic

Co-operation and Development and FAO (OECD-FAO 2023), the U.S. States Department of Agriculture (USDA 2023), as well as the world food supply and demand model developed by the Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries of Japan (PRIMAFF 2023), the Chinese Agricultural Policy Simulation Model (CAPSiM) from the Center for Chinese Agricultural Policy at Peking University (Huang and Xie 2022), and the China Agricultural Monitoring and Early-Warning System (CAMES) from the Market Early Warning Expert Committee of Ministry of Agriculture and Rural Affairs (China, MARA 2024). The Chinese Academy of Agricultural Sciences (CAAS) also maintains a partial equilibrium model called the China Agricultural Sector Model (CASM) to simulate the changing supply and demand dynamics of China's agricultural system. The CASM – codeveloped by the Institute of Agricultural Economics and Development (IAED) of CAAS and the International Food Policy Research Institute (IFPRI) – tracks production, consumption, trade, and prices for 33 key agricultural commodities, enabling researchers to analyze the impacts of various trends and policies on China's agricultural system (CAAS 2024). Table 1 presents the various projections for the supply of and demand for China's main grains in 2030.

**TABLE 2 Recommended values of a healthy diet for each ideal dietary reference system, in kilograms/year**

| Food item        | Actual value in 2023 | Mean values of recommended values of various ideal dietary <sup>a</sup> |                             |
|------------------|----------------------|---|-----------------------------|
|                  |                      | Original value  | Adjusted value <sup>b</sup> |
| Cereals          | 192.95               | 74.83   | 106.89                      |
| Potatoes         | 41.65                | 27.38   | 30.42                       |
| Beans            | 11.00                | 23.73   | 23.73                       |
| Edible oil       | 21.60                | 14.31   | 14.31                       |
| Meat             | 55.67                | 37.80   | 37.80                       |
| Eggs             | 15.19                | 10.49   | 11.92                       |
| Milk             | 37.05                | 109.50  | 109.50                      |
| Aquatic products | 22.22                | 44.26   | 75.01                       |
| Vegetables       | 136.11               | 146.91  | 168.86                      |
| Fruit            | 106.54               | 91.25   | 111.28                      |

Source: CAAS 2024.

Note: a. The averages of the recommended values refer to the average of the minimum and maximum values of the recommended intake of each food for each ideal diet of the Chinese Food Guide Pagoda (2022), the EAT-Lancet dietary, the Mediterranean diet, and data from the Japanese Dietary Pagoda, among others. b. Because the healthy diet recommendation is the actual intake of major foods, such as flour and rice, consumed by residents, this study converted the data according to parameters such as the proportion of the edible portion of each food to obtain adjusted values.

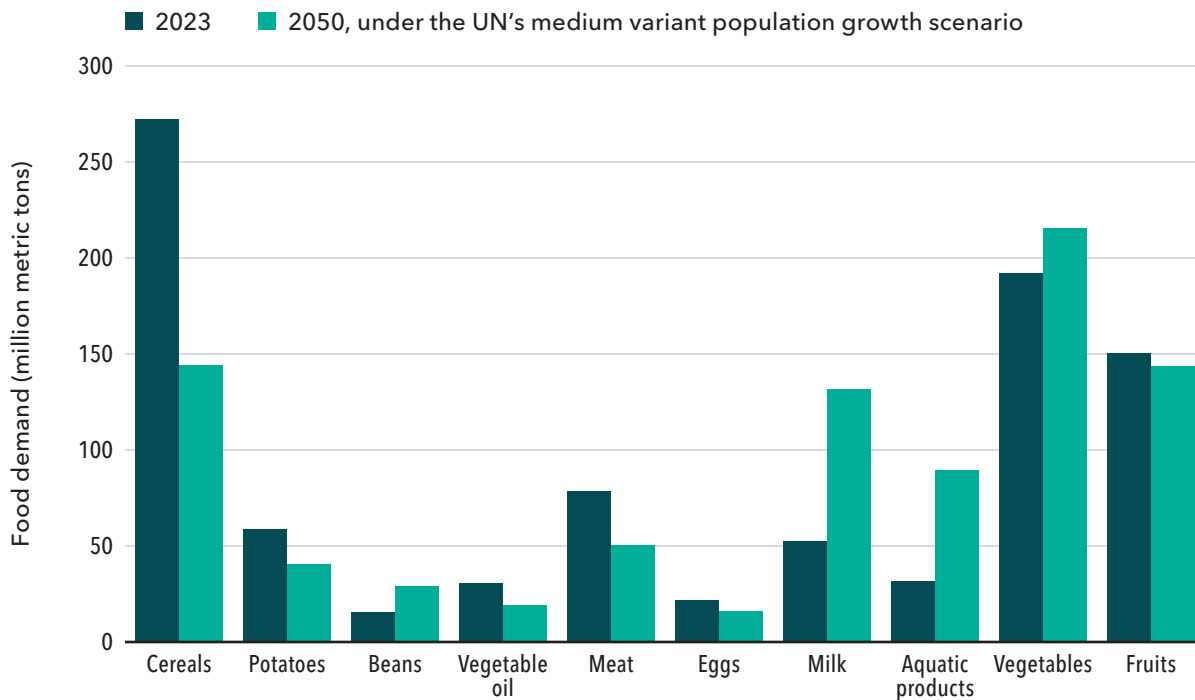
By assuming that China will gradually achieve a shift toward a healthier diet by 2050, we derived a simulation for the ideal diet from a combination of recommended values from various sources, including the Chinese Food Guide Pagoda (2022), the EAT-Lancet diet, the Mediterranean diet, and data from the Japanese Dietary Pagoda, among others. Given the anticipated outcomes of this ideal diet, China is projected to see a significant increase in demand for high-quality proteins such as dairy products and aquatic items, as well as for fruits and vegetables. Conversely, a moderate decrease in demand is expected for cereals, edible oil, and meat, with a focus on achieving adequate energy intake and enhancing overall nutrition to improve national health (Table 2).

The simulation results from the CASM show that per capita food demand for meat in China is projected to decrease from 55.67 kg in 2023 to 37.80 kg in 2050 and from 21.60 kg to 14.31 kg for vegetable oil. On the other hand, per capita demand for milk is projected to increase substantially, from 37.05 kg in 2023 to 109.50 kg in 2050, although this value is still below the per capita milk intake level of the United States. Aquatic products are expected to increase significantly, from 22.22 kg to 75.01 kg.

Under the United Nation's medium variant population growth scenario, China's population will drop to 13.78 billion in 2035 and to 12.88 billion in 2050 (UN 2022). Although the impacts of total population decline and population aging on China's food demand remain unclear, our CASM simulation results find that total food demand for cereals will fall to 144 MMT, and total food demand for high-quality protein foods such as beans, milk, and aquatic products will increase significantly by 2050 (Figure 1). The food demand for milk is expected to rise to 131.49 MMT, a 151.6 percent increase from 2023, while the demand for aquatic products and beans is also expected to rise substantially. Conversely, total demand is expected to decrease, by varying degrees, for staple foods, oils and fats, meat, and eggs.

## KEY GAPS AND OPPORTUNITIES FOR FORESIGHT RESEARCH

Future foresight research based on the CASM will need to comprehensively consider the impact of the following

**FIGURE 1** Projection of food demand by 2050 based on the ideal diet in China

Source: CAAS 2024.

factors to better simulate and predict the transformation of China's agricultural system:

#### **The impact of changes in agricultural production**

**organization forms.** With rural aging and the growth of cooperatives and socialized service organizations, the small-scale farming production model that has lasted for thousands of years may undergo changes in the future, leading to the scaling-up of agricultural production and higher efficiency (Guo, Lv, and Hu 2021; Huang and Yang 2017).

#### **Potential impact of scientific and technological progress.**

Scientific and technological innovation is an important factor in transforming the agricultural system and a core factor in overcoming the constraints of cultivated land and water resources to achieve sustainable agricultural development (Han et al. 2024; Zhang et al. 2024).

**The uncertain impact of the world market.** Under the globalized market, China's agricultural transformation is interconnected with the rest of the world and will bring new opportunities for development of the world's agricultural industry. However, as trade disputes increase, uncertainty in the world agricultural product market is also

increasing, affecting the agricultural transformation of countries around the world, including China (Han, Chen, and Wang 2022; Kim, Steinback, and Zurita 2024).

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Related chapters on the future of food system drivers and impacts, regional and national perspectives, food commodities, and foresight tools are available in our [Table of Contents](#).

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