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TRANSFORMING CHINESE FOOD SYSTEMS FOR BOTH HUMAN AND PLANETARY HEALTH

by Shenggen Fan, Jikun Huang, Fusuo Zhang, Wenhua Zhao, Hongyuan Song, Fengying Nie, Yu Sheng, Jinxia Wang, Jieying Bi and Wenfeng Cong

EXECUTIVE SUMMARY

Over the past four decades, China's food security and nutritional status have improved significantly witnessed by elimination of hunger and poverty, increased diversity of diets, and reduction in child stunting. However, the Chinese food systems will face even greater challenges in the future. These include constraints of natural resources, climate change, multiple challenges of malnutrition, food safety, and external shocks from volatile international market. Fortunately, the Chinese government has made important commitments in the "Fourteenth Five-year Plan" on food and nutrition security, health, the environment and climate change including achieving carbon neutrality by 2060. The purpose of this brief is to review major achievements and their enabling factors, future challenges and government strategies as well as our recommendations to transform Chinese food systems for both human and planetary health. This paper will help to bring voices of emerging economies like China in setting the global food systems agenda, providing useful insights on the transformation of its own food systems as well as those in other countries

INTRODUCTION

Enormous successes have been achieved with regard to food throughout the world in the past but future challenges are massive. Food systems embrace the entire range of actors and their interlinked value-adding activities in the production, aggregation, processing, distribution, consumption, and disposal (loss or waste) of food products that originate from agriculture (incl. livestock), forestry, fisheries, and food industries, and the broader economic, societal, and natural environments in which they are embedded (von Braun et al. 2021; Fan et al. 2021). They also generate massive externalities, and is a cause of many economic, social and health crises including the triple burden of malnutrition (undernourishment or hunger, micronutrient deficiencies or hidden hunger, overweight and obesity), food safety scares and zoonotic pandemics such as the ongoing COVID-19. Thus, urgent actions are needed to transform the current food systems to be nutrition- and health-driven, productive and efficient (thus improving affordability), environmentally sustainable and climate-smart, resilient and inclusive.

Despite rapid ascension in global food production, consumption, trade and investment, the voices of emerging economies are largely absent in setting the global food systems agenda. This will hinder the transformation of their own food systems as well as the global system. Taking China as an example, the country's food systems have experienced substantial transformation for the past four decades, but still face many challenges that threaten both human health and environmental sustainability. Fortunately, the government has recently made several important commitments on food and nutrition security, health, the environment and climate change including achieving carbon neutrality by 2060. This gives a unique opportunity as well as responsibility to reshape food systems to achieve these national goals.

This paper aims to review major achievements, enabling factors, and challenges and to propose a pathway for Chinese food systems for achieving both human and planetary health. Chinese experience and lesson have global implications not only because of its size, but also its strategy to strengthen the south-south cooperation in order to enhance global food security, climate mitigation, resilience to unexpected crises, and protection of world natural resources.

1. EVOLUTION OF FOOD AND NUTRITION SECURITY IN CHINA

Impressive progress in China's growth in agricultural productivity and the subsequent growth in agricultural production has enabled the country to feed nearly 20% of the world's population using only 8% of the world's arable land and 5% of global fresh water (Lu et al. 2015; Huang et al. 2020). During the period of 1978-2020, China's agricultural output (in real term) has grown at the rate of 4.6% a year (more than 60% driven by total factor productivity growth), much higher than 0.9% of annual population growth for the same period of time. In the meantime, the structure of agricultural production has shifted towards high value and high protein products (NBSC 2020). The farm economy is now highly commercialized and the output value of high-value commodities (including vegetables, fruits, livestock and fishery) has on average accounted for around 70% of

agricultural output value (Huang and Shi 2021).

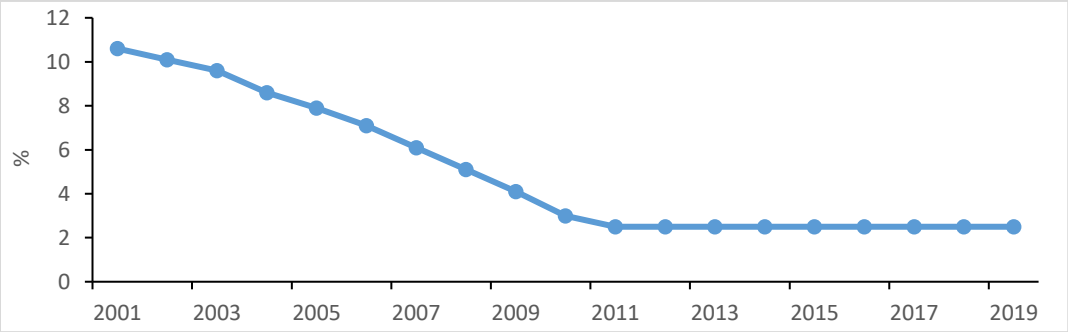
With increased food supply, China has substantially increased the capacity of food supply for its growing and wealthier population. Over the past three decades, the prevalence of global hunger has been on the decline, among which two-thirds of the people who escaped hunger globally live in China (FAO 2020). Between 1990 and 2020, the prevalence of undernutrition in China dropped from 22.9% to below 2.5% (FAO stops reporting when the rate is below 2.5%, thus the hunger rate in China is much lower than 2.5%), and the daily calorie intake per capita increased from 2,814 in 2000 to 3,197 kal/day in 2017 (Table 1). The food consumption pattern also become more diversified, with the proportion of high-protein and high-energy products increased substantially. Data from national household consumption surveys shows that the overall intake of staple food (in particular, grains) decreased by approximately one third for the past three decades, and the daily consumption of vegetables, fruits and meat per capita were more than doubled in 2018 compared to 1997 (Zhao et al. 2018). The prevalence of stunting and underweight in China are well below the average for developing countries, and undernutrition and micronutrient deficiencies have declined sharply (Figures 1 and 2). The overall mortality from cardiovascular diseases, all types of cancers, chronic respiratory diseases and type-2 diabetes has declined from 18.5% in 2015 to 16.5% in 2020.

Table 1. *Calorie supply per capita and per day (kilocalories), 2000-2017*

Year	Brazil	China	India
2000	2880	2814	2380
2005	3078	2883	2270
2010	3230	3044	2442
2015	3238	3187	2461
2016	3236	3172	2496
2017	3248	3197	2517

Source: OECD (2020)

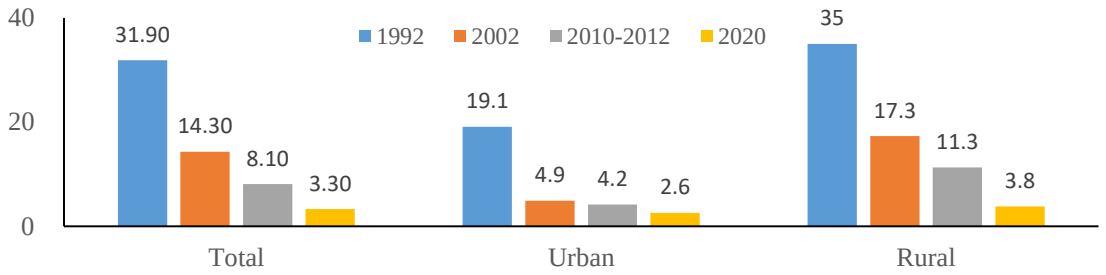
Figure 1. *Percentage of undernourished population in China, 2001-2019*



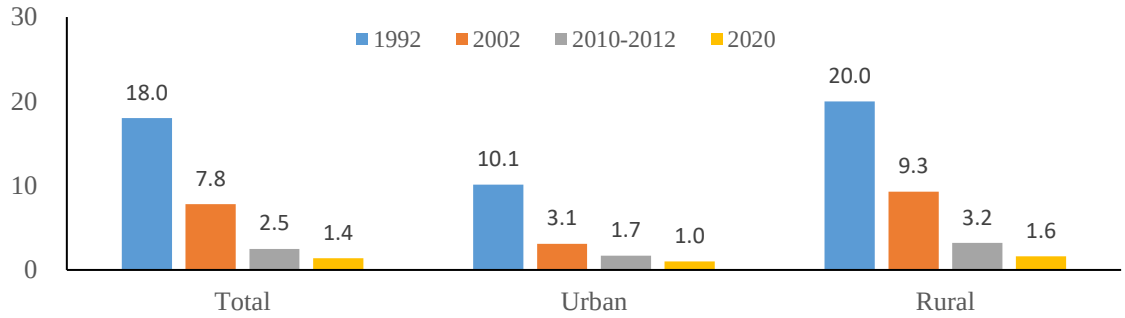
Source: The World Bank (2020)

Figure 2. *Nutrition Statistics of Children under 5 years old in China, 1992-2020*

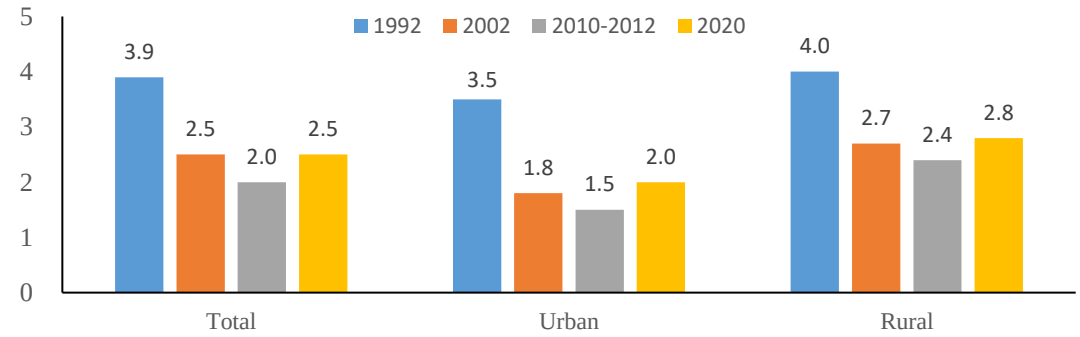
(a) Stuning rate (%)



(b) Under-weight rate (%)



(c) Thin rate (%)



Source: 1992, 2002, 2012 and 2020 China Nutrition and Health Surveys.

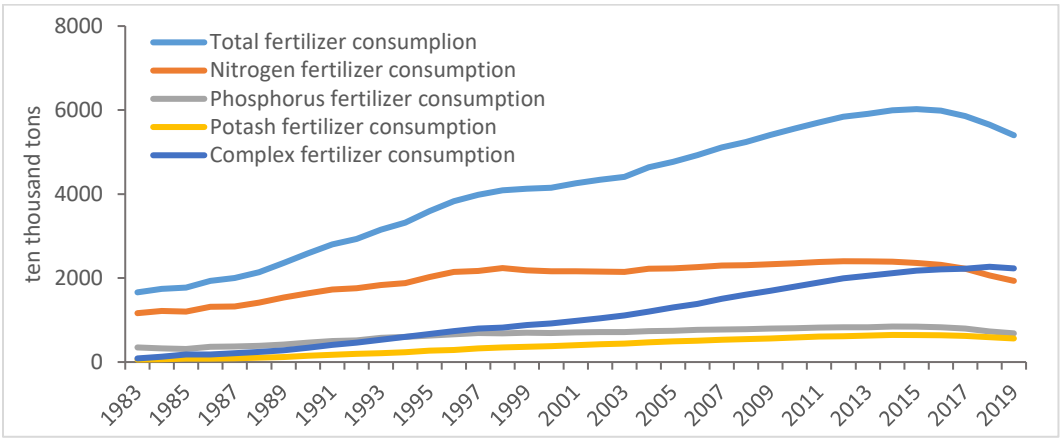
Agricultural market has been gradually reformed domestically and internationally, helping to increase allocative efficiency of the food value chain (Huang and Rozelle 1996; De Brauw, Huang and Rozelle 2004). Domestically, marketization reforms started with the so called nonstrategic products (such as vegetables and fruits) in the mid-1980s, and gradually moved to animal products (fish and meat) and then to crops such as sugarcane, edible oils, cotton and grains (Sicular 1988; Rozelle et al. 2000; Rozelle and Swinnen 2004; Huang and Rozelle 2006). Internationally, China reduced the average import tariff for all agricultural products from 42.2% in 1992 to 12% in 2004, making China one of the freest agricultural trading nations in the world. Equally, remarkable growth also occurred in the upstream and downstream sectors of agriculture. While agriculture only accounted for 6.7% GDP and 25%

employment in 2019, the food systems in China (including agriculture, agribusiness, food processing, packaging, transportation, wholesale and retail trade, food services, finance and insurance, advertising and input supplies) accounted for 23% of GDP and more than 30% of total employment (Fan et al. 2021). Recent trends toward greater concentration of agricultural inputs and food distribution, the increasing role of E-commerce and logistic technologies, and the growing importance of food safety, quality, and other technical requirements have all resulted in dramatic changes in Chinese agri-food systems (Chen et al. 2019; Fan and Swinnen 2020). With the rapid expansion of Internet access and the steady process of logistics infrastructure construction, China is now leading the world in E-commerce and shows the resilience of its food system in coping with the COVID-19 pandemic in 2020.

China has facilitated rural structural transformation and off-farm employment, substantially contributing to poverty reduction and increasing equal accessibility to food. Where off-farm employment was once rare, today, a majority of rural household income is earned off-farm. The share of rural labor off-farm employment had increased from 9.3% in 1978 to 84.4% in 2018 (Li et al. 2021). Agriculture employed 71% of labor in 1978 (Rozelle et al. 1999). By 2019, the share of employment in agriculture fell to 25% in 2019 (NBSC 2020). At the same time, the number of people in rural China in extreme poverty fell from 250 million in 1978 down to zero in 2020 (NBS various years). According to the current nationwide poverty threshold—RMB 2,300 a day in 2010 prices, or slightly more than $2 a day in purchasing power parity (PPP) terms—number of rural poor decreased by 98.99 million for the past decade, and all the remaining 832 poor counties (128 thousand villages) have moved out of poverty (NBS various years). China has become the first developing country to meet the Sustainable Development Goals (SDGs) target one decade ahead of schedule.

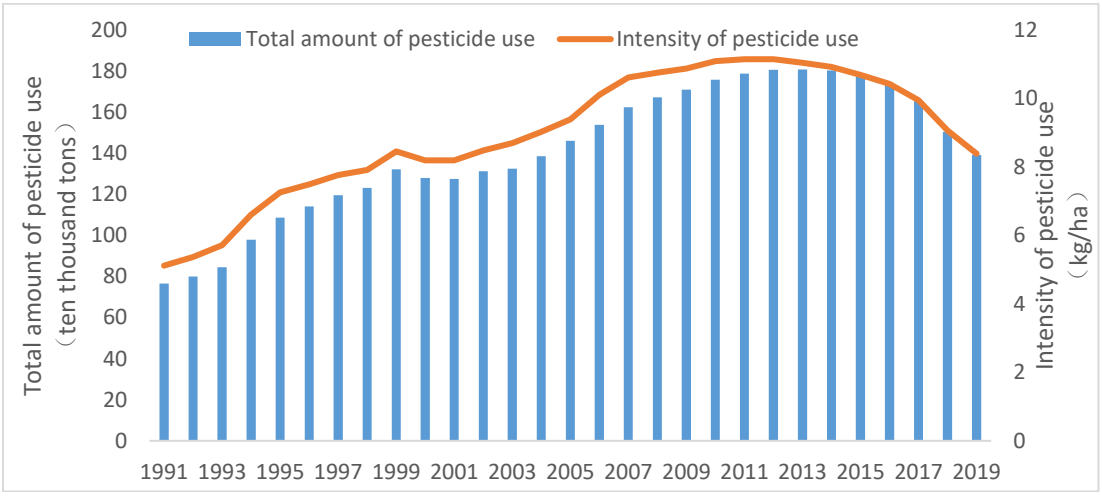
Green development and resilience have been integrated to agricultural development strategy. In terms of resource management, China is one of a few large countries to make substantial public investment in irrigation, flood control and land improvement (Wang et al. 2019). The area of irrigated agricultural land increased from 45 million hectares in 1978 to 68.7 million hectares in 2019 (NBSC 2020). Today, more than half of China's cultivated land is irrigated. Investment in low- to mid-quality land has also helped to improve soil quality and raise agricultural production capacity. In response to environmental degradation and climate change, the government has initiated the first national program to protect natural resources in 2016 and thereafter implemented a series of directories and regulations to tackle the environmental degradation and to restore the agro-ecosystem. In 2021, the newly issued regulation towards low carbon and "dual cycle" rural development highlighted the measures to control livestock wastes, agricultural plastics, and the overuse of fertilizers and pesticides. With these efforts, the use of fertilizers and pesticides have substantially declined since the mid-2010s (Figures 3 and 4). These indicate that China is on the way to develop a greener and more resilient food system facing limited environmental resources and climate changes.

Figure 3. *Total use of fertilizer and its composition change in China: 1984-2019*



Source: China rural statistical yearbook, various years.

Figure 4. *Total use of pesticide and its intensity: 1990-2019*



Source: China rural statistical yearbook, various years.

3. ENABLING FACTORS DRIVING CHINESE FOOD SYSTEMS TRANSFORMATION

Numerous studies have analyzed the factors contributing to China's agricultural growth and food system transformation. These include sequencing policy and investment priorities, embracing technology progress and innovation, integrating food and nutrition security to poverty reduction programs, protecting natural resources and environment, building resilience against risks and shocks, and promoting ICTs and E-commerce.

3.1 Sequential choice of policy and investment initiatives

Sequential choosing and prioritizing policy instruments to meet the stage-by-stage development goal is key in achieving the successful food system transformation. The household responsibility system (HRS),

implemented during the period 1978–84, was regarded as the starting point of China's agricultural and food system transformation. The reform dismantled the people's communes and contracted cultivated land to individual households, largely on the basis of the number of people and/or laborers in the household. These triggered strong growth in both agricultural output and productivity and thus substantially increase food supply (Fan 1991; Lin 1992; Huang and Rozelle 1996; McMillan, Whalley and Zhu 1989; Jin et al. 2002 and Sheng et al. 2020). The HRS reform in land policy has paved the way for other reforms after the reform was completed. These include market reforms since the mid-1980s (Huang, Rozelle and Chang 2004; Huang and Rozelle 2006), and agricultural trade reforms in the 1990s (Anderson, Huang and Ianchovichina 2004; Huang et al. 2007), and stabilizing land tenure policy to improve land reallocation and investment (Gao, Huang and Rozelle 2012; Huang and Ji 2012; Jin and Deininger 2009), and institutional reforms in labor and financial markets (particularly the gradual relaxation of the household registration system or hukou).

Prioritizing investment initiatives is also critical. China invested substantially in rural public infrastructure even before the institutional and market reforms that began in the late 1970s, but mainly focusing on production and transportation related infrastructures. Since Asian financial crisis in the late 1990s, investments in rural areas have been further boosted as part of the financial stimulus package. As a result, China has become one of a few large countries with substantial increases in public investment in water (irrigation and flood) control and land improvement (Wang et al. 2019). Massive investment has also been made to rural roads and wholesale markets fostering market integration and linking hundreds of millions of small farms with retailers and consumers. Highway mileage increased from 890,000 km in 1978 to 10 million km in 2020 (NBS various years), and nearly every village has access to a public paved road. Empirical evidence shows government spending on rural roads has very high impact on agricultural transformation, off-farm employment and poverty reduction (Zhang et al. 2004; Zhang et al. 2019).

3.2 Agricultural R&D and innovation

China has invested significantly in agricultural R&D and developed a strong technology innovation system (Hu and Huang 2011; Babu et al. 2015). In 2015, public expenditure on agricultural R&D was estimated to reach more than RMB 26 billion yuan (roughly USD$4.1 billion), overtaking the public spending of the US and ranking the top in the world (Chai et al. 2019). This system has generated a wide range of innovative technologies used by millions of small and large farms in crop, livestock and fishery production, as well as in agricultural inputs and farm machines.

China has also developed a comprehensive agricultural extension system, despite a twisting path of reform in the past. The system covers all townships across the country and the extension staff work closely with farmers. While the role of the private sector in providing extension services has been rising in recent years, maintaining a strong public extension system is crucial to agricultural production dominated by small farms.

The increased public agricultural R&D investment and the development of agricultural extension system have been translated directly to productivity gains. China was one of the first developing

countries to develop and extend the "green revolution" technology in rice in the 1960s (Stone 1988). Technological changes in wheat, maize, cash crops and animal production have also been impressive since the 1990s (Jin et al. 2010). Empirical studies show the average annual growth rate of TFP in the grain sector increased (by) about 3 per cent; in (the) country's agriculture before the mid-2000s (Fan 1997; Jin et al. 2008). TFP growth rates for cash crops and livestock and the whole agricultural sector were even higher, exceeding 3.5 per cent per year after 1992 (Sheng et al. 2020). Rapid agricultural productivity growth has enabled the country to save its limited land and water resources. Since the mid-1990s, China's agricultural productivity growth has turned to rely on innovations from plant biotechnology. The wide cultivation with the "Bt cotton" is an example of successful uses of genetic modification technology in the developing world—a technological change that has benefited millions of farmers (Huang, Rozelle and Pray 2002). Meanwhile, the recent emerging technologies (e.g. ICTs, big data technology, etc.) are also changing the path of innovations in country's agriculture.

3.3 Poverty reduction schemes and national nutrition programs

The success in poverty reduction (and hunger) in China is not only the result of sustaining rapid economic growth but also the result of the implementation of large-scale, long-lasting, government-led poverty alleviation strategies. Targeting poverty alleviation policies and development-oriented poverty alleviation programs (Liu, Liu and Zhou 2017; Fan and Cho 2021; Cheng, Wang and Chen 2021) have both contributed to the success. First, continued reforms and opening-up policies reduced poverty through economic development (Wang et al. 2008; Yan 2016). Second, development-oriented poverty alleviation policies are an important part of China's anti-poverty strategies. China improved the living conditions of poor areas by implementing preferential development policies, to enable these areas to obtain special development opportunities and to partially offset the constraints associated with poor natural conditions. Development programs in infrastructure and public services were offered to poor areas, which helped them improve the development environment (Yan 2016). Rapid poverty reduction directly contributed to increase the accessibility of food for large proportion of population, thereby reducing hunger in a historic record.

A number of nutrition intervention programs and policies have been implemented to improve national nutrition, where a dynamic government guidance (reflecting the changing status) has played important roles. Examples include the Children Nutrition Monitoring and Improvement Project from 1990 to 1995, Soybean Action Plan of 1996, Chinese Nutrition Improvement Action Plan of 1997, School Milk Project of 2000, Chinese Fortification Project of 2004, Nutrition Improvement Program for Rural Compulsory Education Students since 2012, and Nutrition Improvement Projects in Poverty Regions (YYB for Children under 2 years old) since 2012, among others. In contrast to the nutrition policies of the 1990s, which emphasized the abundance and availability of food, nutrition policies during the past 10 years have placed increasing importance on balanced diets and food safety. The recurring themes of recent policies involve providing recommended nutrient intake and targeted agricultural development based on population and nutritional requirements.

3.4 Environment and resource management practices

China's experience of policy practice in tackling environmental challenges, climate change and rural sustainable development through two ways: economic encouragement and persuasion. Economic encouragement has been more widely used, compared to persuasive-type approach. Through government subsidies, farmers are given the incentive to adopt more environment friendly production technologies which in turn played an important role in alleviating the overuse of fertilizers and chemicals and recycle of wastes from livestock.

Taking irrigation water as an example, the government has traditionally focused on the supply side and relied on building reservoirs to meet the growing water demand (Xie et al. 2009; Wang et al. 2016a). Over time, it has become clear that it is difficult to catch up with the expanding water demand. The government started to advocate irrigation technologies to reduce irrigation withdrawal since the early 1990s (Lohmar et al. 2003; Wang et al. 2020). Another example is Water User Associations which have replaced village collective management of surface irrigation since the mid-1990s. This approach was adopted by most provinces by early 2001, but with mixed results. It is associations with water-saving incentives that achieved more efficient irrigation (Wang et al. 2005; Wang, Zhang and Huang 2016b). Research also reveals a great policy scope for expanding irrigation technologies to generate real water saving in rural areas.

In addition to water preservation, land protection and soil quality improvement have also received more attention. Since the 18th National Congress, the red line for 1.8 billion mu (15 mu= 1 hectare) arable land has been drawn to ensure agricultural production with adequate land resource. Meanwhile, the national Soil-Testing and Fertilizer Recommendation Program in 2005 and the Zero Increase Action Plan in 2015, initiated by Ministry of Agriculture have played a crucial role in holding back the increase in massive fertilizer inputs and nutrient losses, while increasing food production (Jiao et al., 2018). Consequently, agricultural chemicals use (i.e. fertilizer and pesticide) have fallen recently (Figures 3 and 4).

3.5 Strategies in strengthening food system resilience under COVID-19

The impact of the COVID-19 pandemic on the food system has exposed the vulnerabilities of the supply chain throughout the world in 2020, although the extent of disruption varies widely, globally and in Asia. In response to this pandemic shock, food systems in China have been proven relatively resilient when compared with other regions. **The Chinese experience has been widely acknowledged globally and are believed to played important role in fighting the pandemic.** These experiences include 1) early actions must be taken to make sure that the whole supply chain work smoothly through the green channel; 2) well-organized and prompt response of governments; and 3) multi-stakeholders' collaborations (government, scientists, agricultural technicians, private companies, NGOs, O2O platform etc.); 4) collaboration and joint-response between rural and urban areas.

3.6 Reducing the food loss and waste as a national strategy

By developing a national vision and strategy for reducing food loss and waste allows China to take the lead in achieving the UN SDGs for halving food loss and waste. In 2010, the State Grain Administration issued "Recommendations to Combat Food Waste", which include raising public awareness on reducing food waste, enhancing food purchase and storage, accelerating food logistic infrastructure development, improving the standard of food products, developing and disseminating new technologies for food waste reduction, and encouraging food processing businesses to combat food waste through the trusted grain and (edible) oil program. One well known example is the "Clean Your Plate" initiative through advertising campaigns to raise public awareness on reducing food waste. More recently, China issued the Anti-Food Waste Law, and become the first country to enact against food waste activities throughout the developing world.

3.7 ICTs revolution and E-commerce application

The recent development of rural E-commerce has added fuel to food system transformation, providing a new approach to help smallholder farmers overcome barriers to market (Hamad , Elbeltagi and El-Gohary 2018; Jamaluddin 2013; Li et al. 2020a; Li et al. 2020b; Ma, Zhou and Liu 2020; Okoli, Mbarika and McCoy 2010; Rahayu and Day 2017; Yu and Cui 2019). The rural online retail sales in 2019 reached 1.7 trillion yuan, accounting for 16.1% of the total retail sales, and the growth rate was 19.1%, 2.6% higher than that of the total retail sales; In terms of agricultural products, online retail sales reached 397.5 billion yuan in 2019 (China's Ministry of Commerce 2020). Studies have shown that ICTs and rural E-commerce have generated positive externalities for food system transformation including those in regional governance (Liu 2017), social development and women empowerment (Oreglia and Srinivasan 2016; Xu 2016; Yu and Cui 2019), employment (Qi, Zheng and Guo 2019), and household income (Cho and Tobias 2010; Zapata et al. 2016). The successful expansion of rural E-commerce in China and its potential for economic development and poverty alleviation has drawn a great deal of international attention. The World Bank applauded the development of Taobao villages in China as an instrument for poverty reduction and shared prosperity (World Bank 2016).

4. CHALLENGES FACING CHINESE FOOD SYSTEMS

Despite impressive achievement, China's food system is facing a set of emerging challenges. They include slowing down productivity growth, multiple burden of malnutrition particularly micro-nutrient deficiency and overweight/obesity, natural resource degradation, continued rural-urban and regional inequality and increased food imports.

4.1 Slowdown agricultural productivity growth and dominance of smallholder farms

While growing fast in the past, agricultural total factor productivity (TFP) slowed down in recent years. In addition, rising wages and rural labor shortages have

caused Chinese agricultural and food sector to lose competitiveness and profitability (Liu, Wang and Shi 2018; Sheng et al. 2020). Between 2000 and 2018, the average relative comparative advantage index for feed grains, oil crops and meats (other than poultry) declined from 2.0 to around 0.8 (Rao, Liu and Sheng 2020).

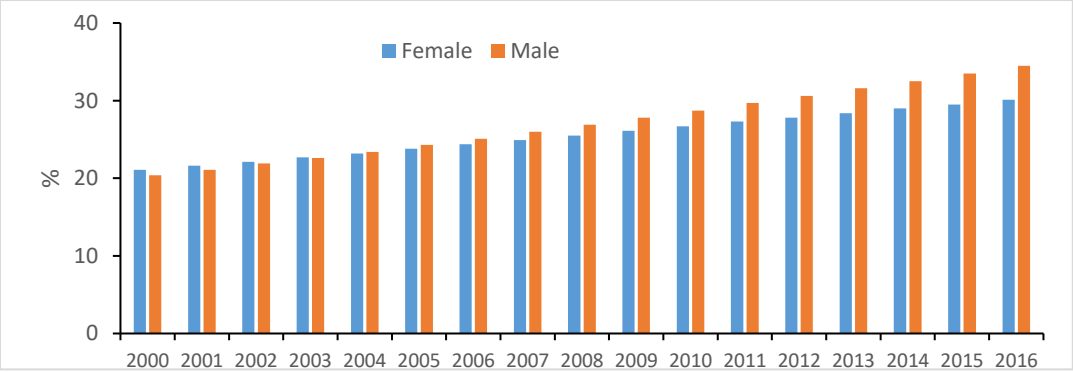
Although ongoing land reforms, such as township land right transfers and "San-Quan-Fen-Zhi" have facilitated land consolidation throughout the country since the mid-2000s (Huang and Ding 2016; Yi et al. 2019), small farms continue to dominate agricultural production. How to increase agricultural productivity of small farms is still essential for national food security and income equality of rural households (Sheng, Ding and Huang 2019).

4.2 Triple burden of malnutrition

The number of undernourished people has declined to almost zero, but it is a challenging task to tackle unbalanced diet and "hidden hunger" for better health. The deficiency of micronutrients such as vitamin A, iron, zinc, and calcium is still prevalent in both urban and rural areas, especially households with lower economic status (Yang et al. 2010). An estimated 21-34% of school-age children were classified as anemic in poorer western provinces, whereas the anemia rate among school-age children at national level is estimated to be 6.1% (State Council 2020). Based on the World Bank (2016) estimate, micronutrient deficiency in China is expected to cause an annual loss of 0.2-0.4% of GDP, or US$2.5-5.0 billion per year.

Overweight and obesity rates are increasing—resulting from the excessive intake of fat, calories, sugar, and physical inactivity. The prevalence of adult overweight and obesity in China jumped from 20.4% in 2000 to 34.3% in 2020 among males and from 21.1% to 30.1% among females (Figure 5). Similarly, the estimated prevalence of overweight and obesity among children under the age of five increased from 5.3% to 6.8% between 1990 and 2020 (NBSC 2020).

Figure 5. *Percentage of obesity and overweight in total population, 2002-2016*



Source: WHO 2020

An increasingly overweight and obese population brings with it a plethora of adverse health and economic consequences. The prevalence of adult diabetes — a chronic disease highly associated with diet — increased from 1% to more than 11.9%

between 1980 and 2020 (NHFPC 2020). Hypertension, diabetes, and other cardiovascular diseases cost China nearly 4% of its GDP, and this figure is expected to double by 2025 if no preventative actions are taken (Popkin 2008).

4.3 Resource scarcity and degradation and climate change

A rapidly urbanizing and richer society puts pressure on increasingly scarce resources including land, water and raw materials. In addition to the limited amount of land, land quality is equally worrisome. Nearly 70% of cultivated land in China is classified as low- or medium-fertility land (Jiao et al. 2018; Luan et al. 2020). Water resource constraints are severe as well. In 2019, China's per capita water resource was only 22% of the global average. In particular, the North China Plain's shallow water table has dropped from 0-3 meters below the surface in 1950 to the depth of 65 meters in recent years (Li, Cui and Zhan 2013; Zhao et al. 2019; Wang et al. 2019).

China is also vulnerable to climate-related risks (Cui et al. 2018; Fang et al. 2018; Rosenzweig et al. 2020). China was among the most disaster-prone countries in the world (Nie, Bi and Zhang 2010; Li et al. 2014), as agro-meteorological disasters alone affect 50 million hectares and 400 million people, and result in loss of RMB 2, 000 billion (about 3% of GDP) annually (CNARCC 2011). Climate change will continue to intensify and the occurrence of extreme weather events and natural disasters associated with climate change will continue to increase (Wang et al. 2020; Rosenzweig et al. 2020).

4.4 Remaining rural-urban and regional inequality

While governments' focus on the agricultural and rural issues has shifted from "poverty reduction" to "rural revitalization", rising rural-urban inequality continues to pose a policy challenge.

The most notable income disparity in China is between urban and rural areas, and between coastal and inland regions. The relative ratio of urban to rural residents' per capita disposable income increased from 2.4 in 1978 to 3.0 in 2010. Although it declined in recent years, the ratio was still as high as 2.66 in 2019 (NBSC 2020). In addition to the coastal to inland gap in GDP per capita (Luo and Zhu 2008), the recent decade witnessed a widening gap in GDP per capita between Northern and Southern regions. In 2013, the gap in GDP per capita growth between Southern and Northern provinces was 0.3, but it increased to 1.9% in 2017 (Rozelle and Hell 2020).

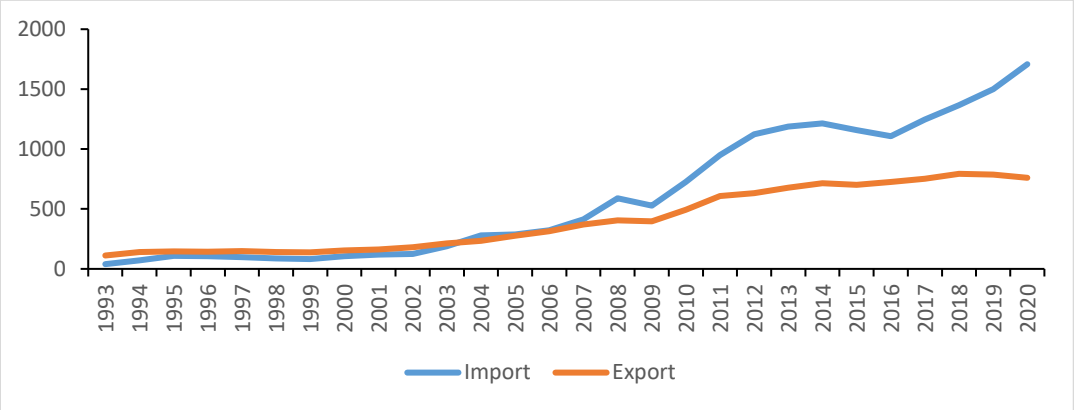
Inequality in China is also reflected in wealth distribution, social protection, public service delivery, nutrition, access to jobs and social programs across and within regions and especially between rural and urban areas. Increasing farmers' incomes at a faster rate will be one of the key policy goals for achieving smooth food system transformation.

4.5 Increasing food imports and uncertainty in global market

China's agricultural trade with the rest of the world has grown rapidly. From 1978 to 2018, China's agricultural trade increased from $5.45 billion to $216.8 billion, with an average annual growth rate of 10% (Rao, Liu and Sheng 2020). At the same time, trade deficit has continued to increase (Figure 6). China has been running an agricultural trade deficit since 2003, and it has surged to $57.3 billion in 2018 (Uncomtrade 2020). The

country imported 100 million tons of soybean and 11.3 million tons of maize in 2020.

Figure 6. *China's agricultural import and export (million US$), 1993-2020*



Source: National Bureau of Statistics and China Customs.

While increasing trade has improved China's food security greatly, it may also bring uncertainty and risks as seen during the China-USA trade disputes. Meanwhile, the persistent COVID-19 pandemic imposes additional uncertainty on international agricultural trade.

5. FUTURE STRATEGIES AND POLICIES

5.1 New vision towards better food systems

To facilitate food system transformation, China has recently released the Fourteenth Five-Year Plan (2021-2025) and "National Food and Nutrition Guideline toward 2035" under the National Strategy of Rural Revitalization. There are two important shifts:

- National development aims to establish "a well-off society in an all-round way" through the Rural Revitalization Strategy.
- Agriculture and rural development shifts its focus towards developing a more efficient, green, inclusive and sustainable food system.

5.2 National food policies towards 2035

The following four major national food policies have been initiated to ensure successful food systems transformations.

- To ensure food security as the bottom line by enforcing the strategies of "Store Grains (food) in Land" (or imposing red line on cultivated land area and improving land productivity) and "Store Grains (food) in Technology" (or raising production capacity through technology innovation). By introducing the "Food Security Law", China is actively enacting to stabilize land areas to ensure grain production of 650 million tons (roughly equal to the 2018 level) by 2025.
- To facilitate the transformation of agricultural production and food consumption towards safe, green and sustainable directions by developing ambitious action plans for achieving

peak carbon dioxide emissions by 2030 and carbon neutrality by 2060.

- To make overall plan to increase the resilience of agricultural and food systems, reducing the negative impact of external shocks such as natural disasters, climate change, plant and animal diseases (i.e. COVID-19) and market uncertainties etc.
- To develop new technologies (e.g., biotechnology and ICTs) to increase agricultural productivity, developing digital agriculture and extending the value chain of agricultural and food products.

5.3 Recommendations: Strengthening institutions, policies and investment using food systems approach

- Given that there are a wide range of issues and multiple dimensions of food systems from production to consumption, the government should consider establishing a new leading group to coordinate policies and investments in food systems at the national and local levels. With this leading group, the following government's efforts and their efficiencies will be further improved, including:
  - Governance capacity to develop more healthy, efficient, green, inclusive and sustainable food systems in general, and addressing issues of small farm modernization, food safety, and scarcity of land and water in particular;
  - The efforts to improve management of emergency food supply in response to external shocks;
  - The efforts of raising awareness of healthy diets and enacting to combat food loss and waste along the value chain.
- Enhance productivity of whole food systems through a more innovative science and technology system.
  - Increase and prioritize agricultural R&D investments on breeding technologies in crop, livestock and fishery, and on agricultural inputs (including faming machinery, fertilizers and chemicals, irrigation, processing, and storage, etc.);
  - Provide more incentives for the private sector to participate and encourage public-private partnership in agricultural R&D and extension activities.
- Further increase investment in restoring natural resources (e.g. land and water) and enhancing its productivity, sustainable use of agricultural and food infrastructure (e.g., irrigation, transportation, etc.), and reduce the costs related to transportation, marketing and food consumption;
- Promote institutional reforms to facilitate land consolidation, help small farms moving up or exiting farms, expand the machinery custom service, and develop more effective farmer cooperatives.
- Build a modern circulation system for agricultural products to improve inclusiveness, efficiency, nutrition, and food safety from "seed to fork". In addition to investment, this requires further reforming agricultural markets, stabilizing food prices, expanding and enhancing agricultural insurance system to mitigate natural and market risks, establishing the integrative protection

system against pests and animal diseases, making full use of E-commerce to extend the value chain from sustainable production in the fields to consumption, and mainstreaming healthy and sustainable diets into the national development strategy.

- Promote green food systems transformation and sustainable development to balance between agricultural growth and sustainable development.
  - Invest in climate-smart agricultural technology and the subsequent adoption of sustainable agricultural practices;
  - Enforce agro-environment legislation and regulations to strengthen natural resource management, and in particular to hold the red line of cultivate land for sustainable food production.
- Improve social protection system. Major efforts should be made to enhance the current social protection system in rural areas and less developed regions.
- Strengthen international cooperation to improve food security in China as well as in the world.
  - Diversify agricultural imports from various countries and enhance trade along the Belt and Road countries;
  - Enhance partnership with CGIAR to use science to transform Chinese and global food systems for achieving both human and planetary health;
  - Participate in global governance on agricultural and food trade;
  - Increase investment in and share the development experience and agricultural technologies with other developing countries through South-South cooperation.

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The authors are:
Shenggen Fan, Dean of Academy of Global Food Economics and Policy, and Chair Professor, China Agricultural University
Jikun Huang, Professor, China Center for Agricultural Policy (CCAP), School of Advanced Agricultural Sciences, Peking University
Fusuo Zhang, Professor, College of Resources and Environmental Sciences (CRES), National Academy of Agriculture Green Development, China Agricultural University
Wenhua Zhao, Professor, National Institute for Nutrition and Health, Chinese Center for Disease Control and Prevention (China CDC)
Hongyuan Song, Former Director, Research Center for Rural Economy (RCRE), Ministry of Agricultural and Rural Affairs
Fengying Nie, Director, Agricultural Information Institute (AII), Chinese Academy of Agricultural Sciences
Yu Sheng, Associate Professor, China Center for Agricultural Policy (CCAP), School of Advanced Agricultural Sciences (SAAS), Peking University
Jinxia Wang, Professor, China Center for Agricultural Policy (CCAP), School of Advanced Agricultural Sciences, Peking University
Jieying Bi, Associate Professor, Agricultural Information Institute (AII), Chinese Academy of Agricultural Sciences (CAAS)
Wenfeng Cong, Associate Professor, College of Resources and Environmental Sciences, National Academy of Agriculture Green Development, China Agricultural University

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For further information about the Scientific Group,
visit **https://sc-fss2021.org** or
contact **info@sc-fss2021.org**
@sc_fss2021