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The triple benefits of slimming and greening the Chinese food system

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Abstract

The Chinese food system has undergone a transition of unprecedented speed, leading to complex interactions with China's economy, health, and the environment. Structural changes experienced by the country over the past decades boosted economic development but worsened the mismatch between food supply and demand, deteriorated the environment, drove obesity and overnutrition levels up, and increased the risk for pathogen spreads due to intensive farming. Here, we propose a strategy for slimming and greening the Chinese food system toward sustainability targets. This strategy takes into account the interlinkages between agricultural production and food consumption across the food system, going beyond agriculture-focused perspectives. We call for a food-system approach with integrated analysis of potential triple benefits for the economy, health, and the environment, as well as multisector collaboration in support of evidence-based policy making.

Main

Despite having a lower per-capita availability of water and cropland than the global average and facing severe resource depletion[1], China recently saw an unprecedented economic growth that has not only shifted millions of people out of poverty and hunger but also reshaped its food system. Important dietary and nutrition changes took place within just two generations in the country, while in other high-income countries the same process took place over more than a century. This quick transition shifted consumption patterns from scarce, carbohydrate-dominated diets toward affluent diets (Figure 1a)–rich in animal protein, sugar, fat, and processed industrial foods[2], along with high food wastage[3]. Economic growth and associated structural changes also led to a decrease in physical labor intensity, an increase in more sedentary occupations[4], and consequently, more obesity and chronic diseases in the population[5] (Figure 1b). Socio-economic changes in China have led to differences in food consumption, thus impacting the economy, public health, and the environment. With ongoing economic growth in China, it is expected that total food demand continues to rise and affluent dietary patterns become even more prevalent, exacerbating the mismatch between food demand and supply and imposing additional economic, health and environmental challenges.

Undernutrition, micronutrient deficiency and overnutrition have all been challenging individual and public health, leading to human suffering and high healthcare expenditures[6]. Health risks measured as million disability-adjusted life years (DALYs) are attributed to low intake in whole grains, nuts and seeds, fruits, vegetables, legumes, and fiber; and high intake in sugar sweetened beverages, red meat, and processed meat[7] (Figure 2a). Notwithstanding notable dietary improvements in China from 1982 to 2011, the overall dietary quality remains suboptimal (Figure 1a) and was estimated to cause 51% of all cardiometabolic deaths and 20.8% of total deaths in 2010–2012[2], underscoring the need for effective public health nutrition strategies to improve diet quality in China. A large gap yawns between poor rural and better-off urban areas, despite the substantially improved overall nutritional status in China[8]. While urbanization is a driving factor behind the dietary shift toward an unhealthy Western diet[9], rural residents had overall less optimal diets compared to urban counterparts (Figure 1a). The prevalence of stunting between 2010 and 2013 among children in urban areas was 4.2%, but 11.3% in rural areas[8]. While rural China experienced a larger decrease in underweight prevalence than urban areas, the increase in overweight population also exceeded growth in urban counterparts[10]. Moreover, food safety remains another urgent issue in China, alongside toxic metals in cropland soils, foodborne bacteria, parasites, and viruses[11–13].

Food systems and economic development are closely interconnected. Notably, the share of the value of agricultural outputs in China's total economy dropped from 24.0% in 1991 to 7.7% in 2020 (Figure 2b) while the whole economy grew. The change in agricultural activity also affected employment in agriculture and the upstream and downstream sectors along the food supply chain. The proportion of the population employed in agriculture in China has declined from 59.7% in 1991 to 25.3% in 2019 (Figure 2b). Also, as much as 19% of grains in China are lost or wasted throughout the supply chain[3], with 4-5% of China's labor force bound to activities that produce waste and amplify the mismatch between food supply and demand[1,9]. Reducing these inefficiencies would further reduce employment in agriculture, and requires either novel agricultural business models or the absorption of employment by other economic sectors.

While agricultural employment declines, finding alternative livelihoods is difficult for rural residents[14,15] as a strict household registration system prevents population mobility[16] and reduces access to the urban education system[14,15]. Under these circumstances, structural changes fuel the urban-rural divide and social inequality in China[17,18]. Similarly, migration and the lifestyle of migrant workers lead to less intake of fruit and vegetables but higher alcohol consumption compared to urban residents[19]. While the reduction of undernutrition has improved labor productivity, both undernutrition and newly rising overnutrition are still a threat to public health and the economy. Sub-optimal dietary patterns with the simultaneous occurrence of both undernutrition and overweight and obesity (i.e., the double burden of malnutrition[8,20]) impairs working forces despite the improvements made from better food accessibility. The loss of individual productivity due to malnutrition is estimated to be more than 10%

of people's lifetime earnings, while the corresponding loss of GDP is as high as 2-3%[21].

The Chinese food system is currently a major driver of environmental damage, contributing 19% of China's greenhouse gas emissions[22] (Figure 2c). The decline from 51% in 1990[22] reflects more the industrialization and rising emissions from other economic sectors than an absolute decline of agricultural emissions. The large increase in the diet-related carbon footprint, from 2.15 in 1980 to 3.04 kg CO_2eq/day/capita in 2017 in urban Beijing, is attributed to the growing consumption of animal-sourced foods[23]. China is the country with the highest ambient nitrogen pollution levels in the world, with agriculture contributing 95% of ammonia emissions and 51% of nitrous oxide emissions[24]. This poses great challenges for reducing air pollution[24] and eutrophication of aquatic systems[25]. Additionally, food production drives soil erosion and biodiversity loss, and intensifies the competition for scarce fertile land and freshwater resources[26–29]. The ongoing diet transition, if not modified, is expected to further exacerbate pressure on the environment and land in China[30]. While evidence is still being built in China, adjusting the dietary patterns of Chinese residents has great potential to reduce environmental pressure.

The expansion of agriculture into natural ecosystems, the sprawl of urban areas[1], the underregulated livestock sector, and the strong interrelations between wild and domestic animals also contribute to the emergence and reassortment of novel pathogens[31,32]. China has been a hotspot of the reassortment of avian influenza viruses in poultry[33], which can be linked to the intensification of the livestock industry in wetland habitats[34]. Livestock farming[35], aquaculture (e.g., China accounting for 58% of global antibiotics in aquaculture)[36] and even crop farming[37] are contributing to the creation of antibiotic resistance. Next to the appearance of novel diseases, agriculture may also impede the health system's response to such pathogens due to increased antibiotic resistance[35,38].

Toward slim and green growth

Solving the issues mentioned above is paramount given the large scale of the Chinese food system and the importance of its impact both domestically and internationally. As these issues cannot be addressed separately and are in fact forming a "Syndemic"[39], we propose to adopt a macro-perspective on the food system that integrates macro-economic thoughts on sustainable transformation and cross-sectoral externalities with regard to health and the environment. To achieve "slim and green growth", a food-system approach is needed that entails an integrated analysis framework able to take into account the interlinkages between agricultural production and food consumption across the overall food system – and that goes beyond agriculture. Slim growth means that those production factors that are used for revenue-generating but not welfare-creating activities – such as food losses or unhealthy foods – need to be freed and relocated to more productive use. Green growth means that hidden costs, such as environmental, health, and social external effects, have to be subtracted to reveal the true growth of a sector[40].

In line with the slim and green growth, a broader perspective of sustainable diets should also target a general reduction of diet-related health risks, including under- and over-nutrition, and diet-related chronic diseases, which is closely related to public health[41]. Food security can be understood in multiple ways such as nutrition security[41], although it is often narrowly interpreted in the Chinese context with emphasis on food availability[42]. In detail, the slim and green growth requires economic growth and social policies to provide people at all life phases with the income to purchase healthy diets. A mix of economic incentives, food and nutrition education, and improved food environments (e.g., food availability, affordability and stability, and food messaging)[43] are further needed to support healthy diet choices.

A slim and green growth also requires broader health objectives that consider indirect risks, ranging from novel and resistant pathogens to agriculture-led air pollution. Recent prospective cohort analyses of Chinese older adults indicate that adopting healthy plant-based diets reduces all-cause mortality[44] and mitigates air pollution hazards on cognitive function[45]. Strategies can be borrowed from the Healthy China 2030 action plan, with focus on the promotion of public health and disease prevention, which can help reduce healthcare needs and the economic burden of disease[46,47]. Under such a national plan, in our view, the development of a preventive healthcare system emphasizing the role of nutrition education and clinical nutrition and promoting the "prevention first" principle offers an opportunity for mitigating health risks rather than treating diseases[47]. A broader scope with consideration of potential impacts on the food system could make the nutrition and health industry a new driving force for health promotion and economic growth, and consider environmental pollution and food safety issues in concert. Such a transformation would also provide employment and advanced training possibilities for educated and unskilled labor, ranging from caregivers, nurses, doctors and food and nutrition educators to people employed in canteens and gastronomy.

For a slim and green growth, more explicit environmental objectives need to define spatially explicit critical loads[48] depending on the vulnerability of local ecosystems and the exposed population. To this end, regulating agriculture is not enough; the entire food supply chain needs restructuring, cuts in food losses, increased resource efficiency, circularity, and the provision of decent livelihoods. Concepts like the green GDP or the Gross Ecosystem Product (GEP) as applied to the Qinghai Province in China provide useful guidance in policy decision making in China[49]. Yet, these concepts need to be broadened to include the public health sector as well.

Transformation by evidence-based policy

The current situation is ripe for change and, in fact, has good initial conditions. Even more importantly, policymakers are aware of the necessity of this change, as both a reduction of the urban-rural divide in the health and economic dimensions and of environmental pollution are core pillars of the fourteenth 5-year plan (2021-2025)[50] in China. China's agricultural sector has changed significantly since the beginning of the 21st century, with particular efforts on reducing agrochemical inputs and promoting organic and ecological agriculture. In 2015, China's Ministry of Agriculture introduced two national strategies to achieve zero growth in the use of chemical fertilizer and pesticides by 2020[51]. As important measures of environmental protection, the individual sets of ten principles addressing air[52], water[53], and soil[42], ecological fiscal transfer schemes[54], and the recent pledge of the climate neutrality ambition in 2060 also put forward higher requirements for sustainability in agricultural production and food processing. As an important measure for the improvement of dietary behavior and population health, the updated "Chinese Dietary Guidelines" (taking the EAT-Lancet guideline into consideration)[28] stresses the key role of diet and nutrition for both public and planetary health.

For the transformation of the food system toward slim and sustainable growth, certain practices need to be changed to simultaneously reduce hidden environmental, social, and health costs. Table 1 & 2 provides a cross-sectoral overview on potential interventions in the Chinese food system. For instance, practices such as wild animals being sold in wet markets and highly polluting aquaculture production must be reduced. Livestock industries have to be shrunk, particularly in high-risk areas such as wetland habitats to avoid the emergence of novel pathogens[34]. The economic activities and employment of labor force in the upstream and downstream industries of agriculture could undergo substantial changes too. Rather than subsidizing agricultural production and thereby escalating pollution, exiting payments to reduce livestock density may facilitate rapid structural change[55]. Diverting subsidies into education programs can help build up food and nutrition knowledge and practices[17], which provides an opportunity to foster healthy diets and change consumption preferences[56]. These education programs, targeting in particular younger people and their families in rural areas[57,58], could help reduce the urban-rural divide; left-behind children are the primary group facing micronutrient deficiency, stunting, and cognitive issues[17,18]. There is evidence that parents' diets changed for the better as a consequence of nutrition education in kindergartens[59]. The long-term benefits of promoting food and nutrition education programs for improving human capital, preventing human health risks, and reducing environmental damages deserve more research and evidence. At the same time, alternative livelihoods in rural areas are needed that allow for structural change and have higher real productivity. One opportunity may lie in the horticultural sector, which can provide a synergetic effect on the economy and the environment. In contrast to the livestock industry[24,25], the horticultural sector in combination with strict sustainability targets – and facilitated by improved production technology[60,61] – has benefits with respect to public health and the environment[62] through reduced resource consumption and stronger soil conservation than the cultivation of grain crops. In addition, the horticulture industry has proven to provide livelihoods for many smallholders[63] and much higher labor intensity on average than the livestock sector[64].

These changes indicate potential trajectories that research will have to show how constraints on agricultural production do not jeopardize the gains in food security of the past. The linkage between the food system and the environment and health sectors is central to its transformation both because of synergies and potential trade-offs among food, environmental and health plans. Metrics with a sustainability focus (e.g., green GDP[65]) will help illustrate the connectedness of these different sectors so that improvements in one sector (e.g., increased food security) at the expense of another (e.g., higher GHG emissions) can be more easily detected and thus avoided. The potential major challenges associated with food system transformation are lock-ins of infrastructure investments and unwillingness to pay for the true cost of food, as well as the need to understand the scope of the problem at the actor level - all of which require strategies of maximizing the co-benefits between the economic, public health, and environmental aspects while minimizing potential trade-offs. Our perspective provides a food-system viewpoint and solicits a range of potential measures; greater scientific evidence on the synergies and trade-offs between these measures is warranted.

Integrative analysis for a systemic transformation

China needs a systemic transformation of the food system with an economy-wide perspective instead of incremental changes toward single-targeted objectives. Thus, integrative analysis of potential triple benefits for economy, health, and the environment is necessary despite some activities already being implemented (e.g., regulations about zero growth in chemical fertilizer and pesticides[51,66]).

Lessons can be learned from the climate change community, e.g., with respect to the energy transition[67]. Here, pathways were designed for a sustainability transition that achieve the overarching goals, mapping out the technological measures, the required scale and the timing of the transformation, as well as suitable policy instruments. Such pathways can be further improved to account for market imperfections, novel technologies or even side-effects of the transformation, such as employment impacts on unskilled labor. The big advantage of these pathways compared to the large body of literature on individual policy interventions is that they allow for enquiring the optimal relative ambition levels across individual measures, assessing whether the overall targets can be met, and combining them in a way that the achievement of side-goals is not impaired.

Externalities on economy, public health, and the environment are omnipresent within food systems and thus the economic problem is how to incentivize socially optimal food production and consumption. Given the wide range of economic, health, and environmental problems connected to the food system, the food system transformation is a considerably more “wicked problem” than the energy transition. Policy instruments in the food system are more heterogeneous than in the energy system, since a central instrument such as greenhouse gas pricing is insufficient to transform the food system. These extant hidden costs are due to not only various market failures but also policy failures that prevent food systems from operating at environmental, social, and economic optimal levels. Economists can make key contributions to the analysis of food systems by developing methods and metrics to reveal the true cost of food systems[68]. It is utterly important to break disciplinary silos and integrate these metrics into a system approach with a large-scale view, which alters the frame of the analysis and requires multisectoral collaboration. We thus suggest considerably widening the perspective beyond agriculture or the food supply chain to capture the entire nature of the problem, and to identify solutions subsequently. While most interventions focus on a specific primary policy target, they also hold strong interaction with other targets (Table 1 & 2). Policy-making should therefore be more integrated. Similar to "health-in-all-policies" (HiAP)[69], we need an "environment-in-all-policies" such that, for example, environmental criteria find entry into nutrition guidelines, or environmental and nutrition targets are integrated into agricultural R&D funding schemes. Finally, while economic evaluations already play a role in today's policy-making, we argue to open the perspective of economic assessments beyond the regulated sector, also toward impacts such policies may have on social inequality, urban-rural divide, migration and other economic sectors.

Future research yet needs to show how these – or further policies – can be combined to achieve a transformation, and at which ambition level they need to be employed to achieve the food system targets[70]. For many of these policies, it is still unclear how effective they can be at achieving a transformation in quantitative terms (e.g., using econometric policy-evaluation methods). To explore feasible transformation pathways, agendas toward sustainable food systems in China will therefore require multidisciplinary and synergistic approaches, more scientific evidence, and more collaborative work[71].

There are several important scientific panels and initiatives functioning as science-policy initiatives for food systems transformation[72]. The International Panel of Experts on Sustainable Food Systems (IPES-Food), for instance, where FAO is playing an important role to promote the agroecological food movement and shift the paradigm from industrial agriculture to diversified agroecological systems. The Chinese government has also been joining force with its vibrant civil society actors that actively advocate for agroecology. In addition to producer-side measures, transforming the Chinese food systems requires consumer-side measures. This implies a scope systematically utilizing data and modeling tools in the food system to fill in knowledge gaps. Coordination of high-quality data collection, econometric analysis of policy impacts, sophisticated model development and application, and team-based research output as a systematic collaborative action network are prerequisites for supporting targeted policymaking for the Chinese food system transformation[73]. By exchanging with the Food Systems Dashbord[74], the Chinese

Food Systems Dashboard (CFSD) has been initiated to provide the public and scientific communities with a holistic data view of the Chinese food system and visualization services for users to obtain and analyze the food system indicators for various regions of China and different economic levels (Figure 3). As illustrated by Figure 1a, the CFSD initiative facilitates better understanding about rural- and urban-specific situations related to the consumption of various food groups. The CFSD aims to provide a harmonized and curated basis for integrated analyses to explore food system sustainable pathways by considering synergies in a consistent manner. A unified framework will be further developed by connecting integrated assessment models[75] that incorporates local information. Exchange with national and global science and decision maker networks will aid successful food systems transformation in China. A commissioned China-focused country study by the Food System Economics Commission (FSEC) is one example of such collaborative work. These initiatives are about catalyzing sustainability research with a focus on the Chinese food system – taking serious consideration of existing policies, using fine-scale data and involving other Chinese and international research partners[66]. This network has fostered new collaborative research, opinion exchange, and increased research capacity[44,66]. Resulting insights can be fed back into international science-policy initiatives such as FSEC and IPES-Food, and act as a role model for sustainability promotion in other sectors and regions.

Figures

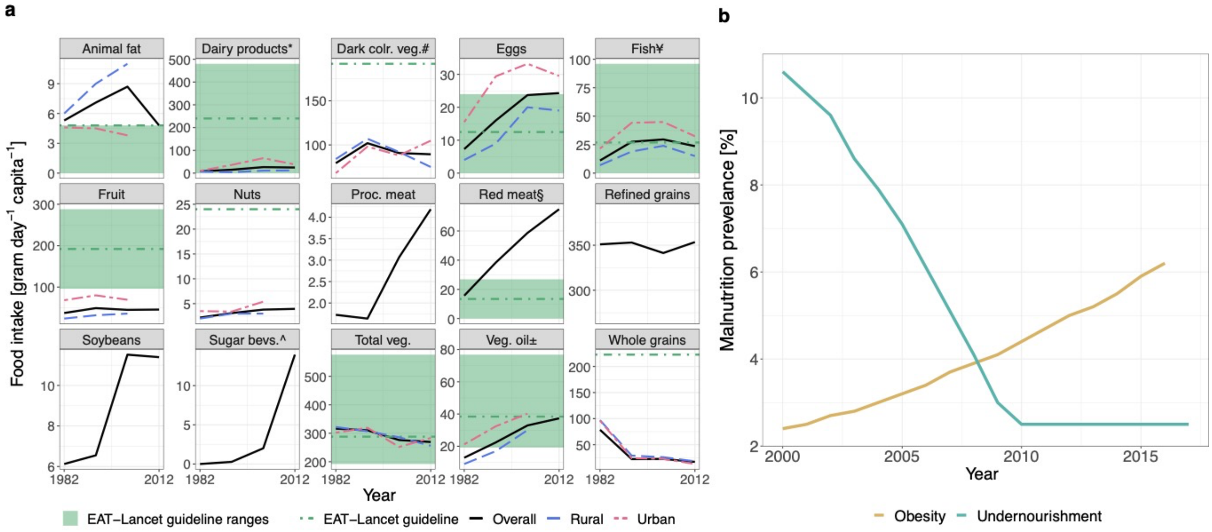

Figure 1: Food intake per day per capita and malnutrition prevalence in China. a) Food intake per capita with the unit of gram per day in China (solid line in black), and in its rural and urban areas (dash lines in blue and red) between 1982 and 2011, based on CNNS national representative survey data[2] and the China Nutrition Statistics Yearbook (CNSY)[76] w.r.t. the EAT-Lancet guideline (levels as dash lines and ranges as shaded area in green)[28]. There are 15 food groups considered in CNNS. *: total dairy products; §: including ruminant meat and pork; ¥: fish, shellfish, and other seafood; ^: sugar-sweetened beverages; #: dark colored vegetables including dark green, red, and orange vegetables; ±: vegetable oils for cooking. b) Share of undernourishment and obesity (age >= 18 years old) in China's total population; the share of undernourishment is reported as <2.5% after 2009-2011 based on FAOSTAT[77]. Intake of refined and whole grains, red and processed meat, and sugar beverages was scaled to total energy of 2400 kcal from CNNS[2]. Intake of total and dark colored vegetables, vegetable oils, eggs, dairy products, fish, animal fat was from the CNSY[76]. Intake of fruits, soybeans, and nuts in 1982-2002 was from the CNSY and that in 2012 was CNNS[2]. For rural and urban statistics, all data were from the CNSY, among which intake of whole grains was partitioned from total grains according to their shares[2]; there are no related data available for the intake of processed meat, red meat, refined grains, soybeans, and sugar-sweetened beverages in urban and rural areas.

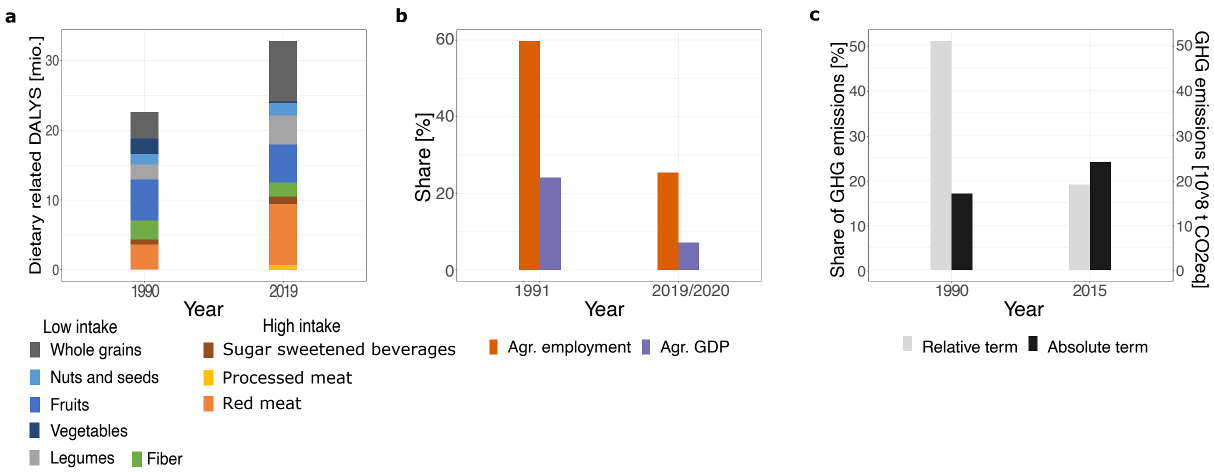

Figure 2: Economic, public health and environment impacts of the Chinese food system. a) risks measured as million disability-adjusted life years (DALYs) related to diets which are categorized in low intake in whole grains, nuts and seeds, fruits, vegetables, legumes, and fiber; and high intake in sugar sweetened beverage, red meat, and processed meat, based on Global Disease Burden[7]; b) share of agricultural employment in 1991 and 2019 and gross domestic production (GDP) in 1991 and 2020, based on world development indicators[78];c) GHG emissions from the Chinese food system in relative and absolute terms in 1990 and 2015[22].

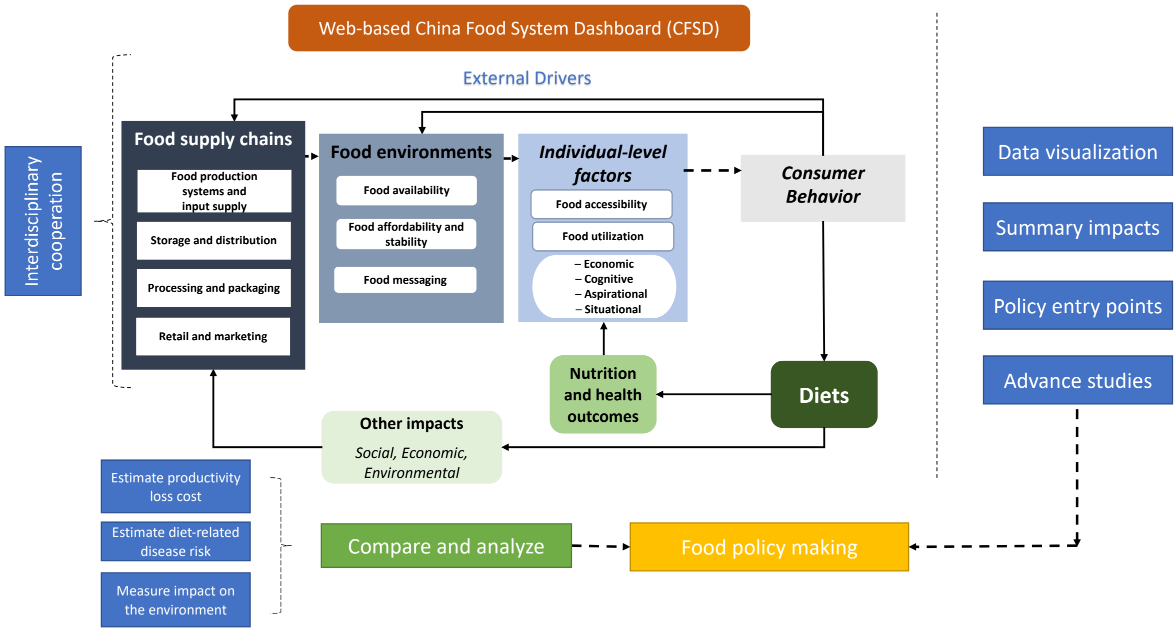

Figure 3: The Chinese food system dashboard (CFSD) framework to visualize and analyze the food system indictors. This serves as a harmonized and curated basis that connects integrated assessment models for integrated analyses to explore food system sustainable pathways. This framework is adapted from JHU FSD framework[74].

Tables

Table 1. Objectives for the Chinese food system transformation with regard to subsystems of agricultural and food production, and food processing and retail. Exemplary interventions with a primary target also may have co-benefits with regards to secondary targets. We indicate potential (co-) benefits for economy (ec), public health (h) and the environment (en) with "+" for clear implications; "+/-" for neutral implications.

Sub-System	Objectives	Interventions to achieve primary targets	Examples for co-benefits with secondary targets
Agricultural and food production	• Operate agricultural and food production within planetary boundaries • Promote future-proof and resilient business models • Use and preserve ecosystem services	Promote agricultural extension and educational programs for smallholders on regenerative agricultural practices [en: +]	• Diversified production improves nutritional status [h: +] • Integration of ecosystem services reduces costs [ec: +] • Improved rural livelihoods reduce urban-rural divide [ec: +]
		Phase out subsidies to rectify price distortion and repurpose subsidies to promote green agricultural technologies [en: +]	• Support of structural change of food systems [ec: +] • Improves health via reduced pollution [h: +]
		Internalize environmental externalities, e.g., via tax reform [en: +]	• Double dividend of Pigouvian taxes [ec: +] • Improves health via reduced pollution [h: +]
		Facilitate structural change within agriculture (e.g., advanced training or professional reorientation, support for major investments, exit payments) [ec: +; en: +; h: +]	• Divert support from polluting to sustainable farm systems [en: +]
		Promote diverse and hybrid business models (e.g., agritourism, direct marketing, collaborations with water works or city councils) [ec: +]	• Pioneers of sustainable farming can gain more from agritourism and direct marketing [en: +, h: +/-] • Payment for ecosystem service provision [en: +]
		R&D investment [ec: +]	• Research programs should be oriented toward environmental and nutritional targets [en: +, h: +]
Food processing and retail	• Reduce the extent of food processing • Reduce the environmental footprint (e.g., energy requirements in transport, cooling, and processing) • Reduce food loss and the resulting overproduction	Improve tracking of products within food supply chains to safeguard food safety [h: +]	• Facilitates life-cycle inventories to better assess environmental footprints through the food value chains [en: +] • Increases trust in food system and willingness to pay for environmental, animal welfare and health attributes of products [en: +; ec: +]
		Develop new food preservation and transport technologies [ec: +]	• Reduces food loss [en: +] • Improves food safety but may also reduce fresh product consumption [h: +/-]
		Promote modern direct marketing of products by farmers [ec: +]	• Empower consumers via direct feedback to express their wishes for sustainable products [en: +]
		Improve regulations and legislation about food advertising and labelling to restrict unhealthy products (e.g., ultra-processed foods) [h: +]	• Large synergies between healthy and environmental-friendly consumption [en: +] • Economic public health benefits may outweigh reduced added-value in food industry [ec: +/-]
		Labelling and pre-selection of healthy and sustainable options in food delivery apps [en: +; h: +]	• Trustworthy labeling can improve profit margins [ec: +]

Table 2. Objectives for the Chinese food system transformation with regard to subsystems of food consumption, public health and healthcare system, and non-food economy. Exemplary interventions with a primary target also may have co-benefits with regards to secondary targets. We indicate potential (co-) benefits for economy (ec), public health (h) and the environment (en) with "+" for clear implications; "+/-" for neutral implications.

Sub-System	Objectives	Interventions to achieve primary targets	Examples for co-benefits with secondary targets
Food consumption	• Improve food security and nutrition quality • Reduce food waste and the resulting overproduction • Improve access and affordability of healthy and sustainable diets	Income transfers for food insecure population groups [h: +]	• Help people to overcome poverty trap [ec: +] • Improved human capital [ec: +] • Reduce economic inequality [ec: +]
		Develop dietary guidance (e.g., dietary guidelines) for healthy and sustainable food [en: +; h: +]	• Improved human capital [ec: +] • Reduce medical expenditure and economic burden [ec: +]
		Enforcing healthy and sustainable offers in canteens, expand population coverage of public food provision, improving their financial resources [en: +; h: +]	• Permanent direct marketing between canteens and farmers can offer business models for sustainable farming [ec: +] • Preventive health services reduce treatment costs [ec: +]
		Introduce nutrition classes in kindergartens and schools [h: +]	• Preventive health services reduce treatment costs [ec: +] • Healthy plant-based nutrition positive for environment [en: +]
		Nutrition counseling for prevention in healthcare system [h: +]	• Preventive health services reduce treatment costs [ec: +] • Offers novel career perspectives for low-educated caregivers [ec: +]
		Campaigns for consumers to adopt practices to improve efficiency in cooking, food preservation, and waste disposal [en: +]	• Reducing waste and preserving food surpluses means reducing food expenditure and improving food security for poor [ec: +, h: +]
Public health and healthcare system	• Prevent chronic disease and improve resilience of population by using dietary interventions • Adopt a one-health perspective and extend healthcare system to more societal spheres	Educate nutritionists, dietitians, etc. [h: +]	• Preventive health services reduce treatment costs [ec: +] • Healthy plant-based nutrition positive for environment [en: +]
		Improve nutrition in hospitals and sanatoriums, initiating healthier diet after treatment [h: +]	• Permanent direct marketing between canteens and farmers can offer business models for sustainable farming [ec: +] • Public health prevention measures reduce treatment costs [ec: +]
		Include public health experts and one-health experts in planning councils (e.g., for urban and rural development) [h: +]	• Improved labor productivity [ec: +] • Mitigation and reduced exposure to environmental pollution [en: +]
Non-Food Economy	• Reduce economic and health inequality and integrate urban and rural areas • Develop holistic concepts of public welfare and economic development • Improve cross-sector and rural-urban labor migration	Invest in high-quality education in rural areas [ec: +]	• Improved resource efficiency [en: +] • Higher awareness for health and pollution [h: +]
		Adopt holistic indicators for measuring welfare and account for cross-sectoral external effects, such as the Green GDP [ec: +; en: +; h: +]	• Reveal hidden costs related to economy, public health, and the environment [ec: +; en: +; h: +]
		Diverting premiums toward retraining programs (e.g., for livestock farmers) [ec: +]	• Facilitates convergence to a more sustainable food system [en: +] • Facilitates successful migration [ec: +]

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Ethics declaration - Competing interests

The authors declare no competing interests.