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Achieving a resilient food system in mega-cities: a look at Chengdu responses to COVID-19, climate change and other shocks and stresses



Chengdu, the fourth largest Chinese city, with more than 20 million inhabitants, is undergoing a period of rapid population growth, urbanization and city expansion. This presents important opportunities for city development while there are challenges to multiple aspects, including building a resilient city region food system (CRFS) to serve the large population and ensure physical and economic access to healthy diets. In the past five years, the mega-city has encountered external shocks and stresses related to climate and the COVID-19 pandemic, which have revealed the increasing risks faced by local food systems. To mitigate the negative impacts of the shocks and stresses, the city took action to improve the resilience capacities of the CRFS and stakeholders in response to emergencies. Meanwhile, much remains to be done and translated into improved systemic strategies and collective actions that can further facilitate transformation towards resilient and sustainable CRFS in a rapidly developing mega-city.

A snapshot of the complexity of a mega-city's food systems

Chengdu is the capital city of Sichuan Province and a national central city located in the west of China. The population is 21.19 million with 79.5 percent living in urban areas. The relatively abundant natural resources and large area of land around the built-up areas in Chengdu have permitted the development of urban and peri-urban agriculture that contribute significantly to food self-sufficiency. Meanwhile, the largely diversified food demands and complex market systems that have developed in the metropolis have highlighted the

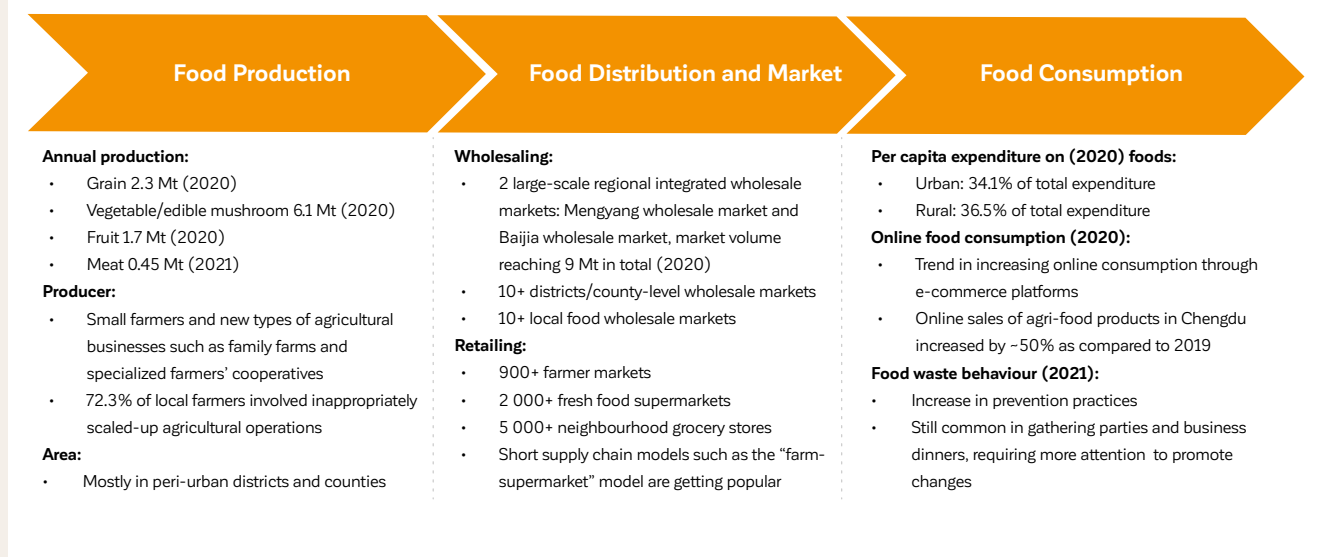
importance of food imports and efficient food flows in and out of the city (Figure 1).

Food production is mostly located in peri-urban districts and counties, grains, vegetables, mushrooms, fruits and pork. The city has developed a series of agricultural industrial parks to facilitate the development of relevant industries, and integration of industrial chains. Leading industries are first identified in each industrial park, and supporting resources are gathered and coordinated for them.

The food supply systems in Chengdu are complex and diversified, with many interactions with larger markets across the country and even the globe. Two large-scale wholesale markets, located in the city, play key roles in food supply at the city and regional scale. One is the Mengyang wholesale market (Sichuan International Agricultural Product Trading Center), which serves as a regional distribution hub for many cities in Sichuan Province; the other is the Baijia wholesale market (Chengdu Agricultural Product Center Wholesale Market) that covers 60 to 80 percent of total food consumption in Chengdu. Food retailers in Chengdu include thousands of farmers' markets, fresh food supermarkets and neighbourhood grocery stores where city dwellers have access to buy their food.

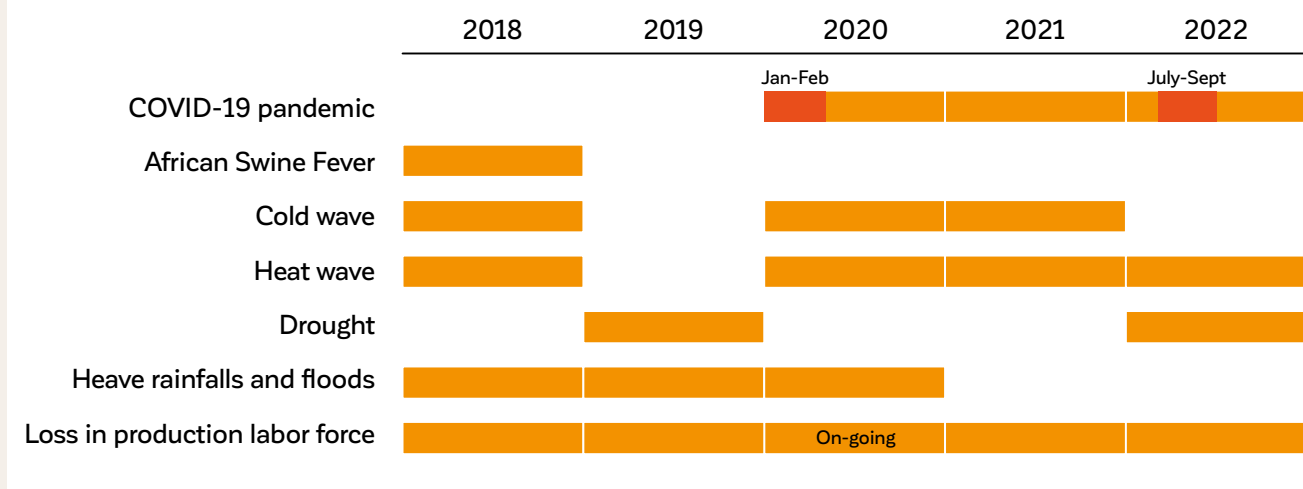
In China, food security is one of the key responsibilities in cities. In addition to the "Rice Bag" programme, which aims to secure grain production and supply, there is the "Vegetable Basket" programme that covers vegetables, fruits, meat, egg, milk, fish, etc., which was initiated in 1988. Since then, the programmes have lead policy in promoting residents' food supply at the

Figure 1 Overview of the city region food system in Chengdu¹



1 Data sourced from the municipal statistics yearbooks, policy reports and planning documents (China)

Figure 2 Timeline of shocks and stresses in Chengdu over the past five years. Red area represents periods of COVID-19 lockdown in Chengdu (partial lockdown most of the time).



local level. The implementation of the programmes has been conducted and evaluated through a system of mayor responsibility, which is one of the key drivers of continuous transformative action in the local agrifood sector.

The negative impacts of multiple shocks and stresses

Figure 2 illustrates the shocks and stresses that have impacted the CRFS in Chengdu over the past five years.

The main category is **climate-related shocks**, including a cold wave, a heat wave, drought and floods, which are quite frequent and have been continuous events since 2018 and even earlier, sometimes occurring several years in a row. Generally speaking, the agricultural production sector is the most vulnerable to climate shocks (Figure 3), given that extreme climate conditions can destroy suitable growing environments for agricultural produce. Farmers do not always have access to sufficient resources and cannot handle the changing situation. As a result, producers, who have faced these shocks, and whose income has been affected as a result of reduced sales and lower prices have also noted the lower yield and quality of their produce.

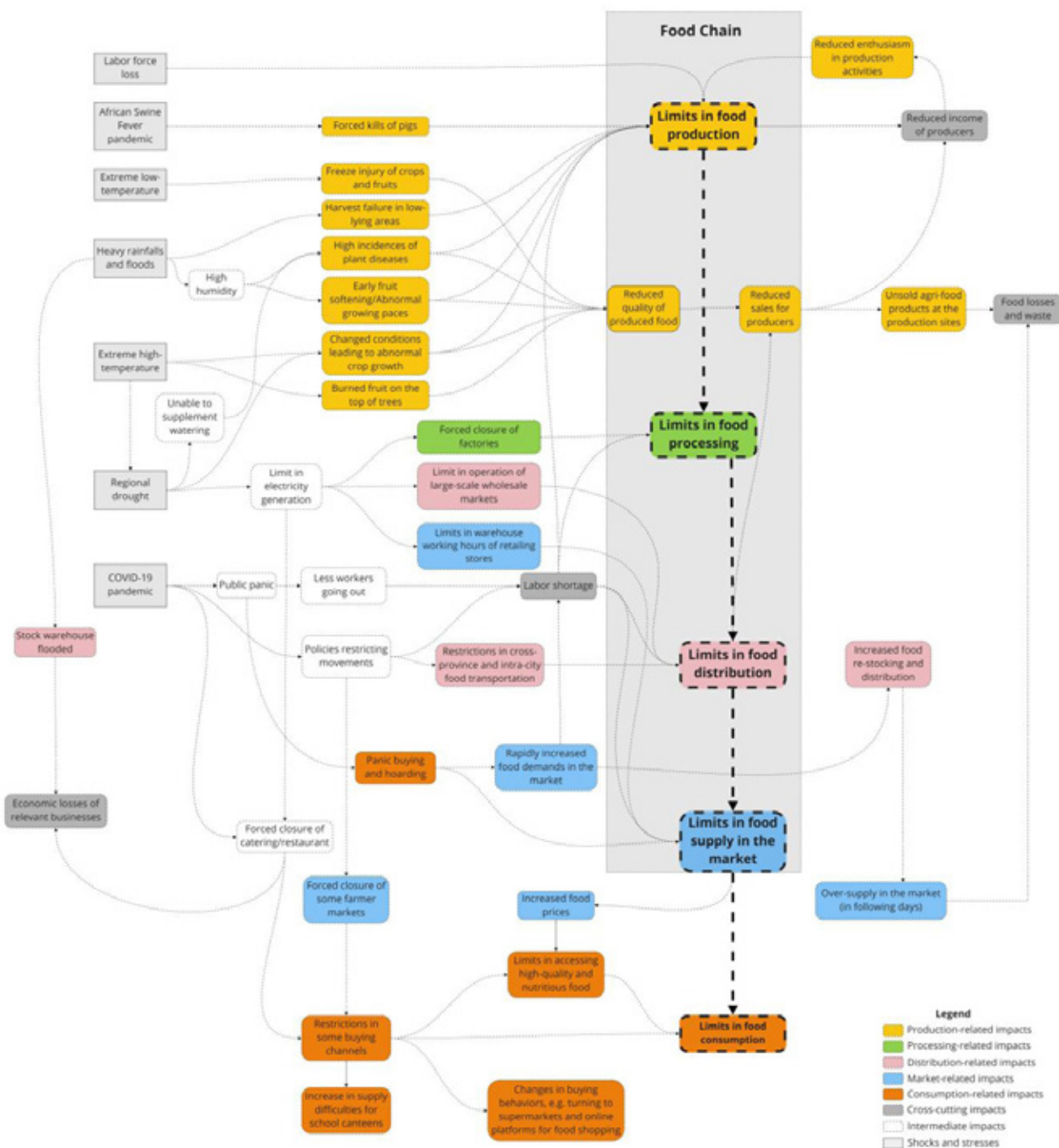
As a result of climate change, it is likely that climate shocks will continue to occur. Therefore, there is an urgent need for innovations in crop production technologies to help adapt to the changing

environment, and measures to mitigate the production of greenhouse gases (GHG).

Epidemic events have considerably affected the CRFS in recent years, while also triggering long-term changes (Figure 3). The African swine fever outbreak in 2018 caused disruptive impacts to the pork industry. Many producers of pork encountered huge economic losses and even business failure, which has resulted in an observed reduced willingness to invest in this industry. The number of small producers has decreased; only mid- and large-scale producers have remained, as they are more resilient to shocks and stresses. Although a series of supporting policies were released in the years following, fluctuations in the pork product market, and the negative impacts upon businesses in the industry, seem to be a lasting trend requiring close monitoring and adjustment with relevant interventions.

Undoubtedly, the COVID-19 pandemic has been the most significant cause of the impact in the CRFS since 2020 (Figure 3): the beginning of 2020; July in 2022; August to September in 2022, when there were partial or full lockdowns and the CRFS was largely affected. Distinct from other shock events, the COVID-19 pandemic has affected the CRFS on a systemic scale. Nearly all food systems nodes were impacted to various extents. In most cases, residents' access to food in Chengdu was not severely affected, however there were disruptions to cross-province transportation of food, labour shortages along the food supply chains and operational difficulties in the catering industry during each outbreak of the pandemic.

Figure 3 Impacts of shocks and stresses over the past five years in the Chengdu city region food system



Measures taken in Chengdu to improve the resilience to shocks and stresses

According to the interviews and focus group discussions held with local CRFS stakeholders, two key lessons were drawn from Chengdu on how CRFS resilience can be improved through public policies and collective initiatives.

1. Every level of government attaches high importance to securing the stability of food supplies in the city

Overall, the public sector, including all levels of government, take responsibility for guaranteeing food security very seriously, thus great emphasis is placed on agrifood related issues in public policies, through coordination of technical, human, financial and land resources that support local food availability and access.

From the viewpoint of **production** (Table 1), the High-Standard Farmland Construction Initiative was

initiated at the national level in 2013 and has been implemented at the city scale over the years. The Initiative has considerably improved the productivity of farmland, sustainability and resilience to natural disasters. Recently, the [One Belt, Ten Parks and Hundred Districts Initiative](#) was developed to improve self-sufficiency in staple foods in Chengdu through support to the production of local grain products. [Agricultural insurance](#) was mentioned frequently by producers interviewed as being an important element of resilience in response to emergencies. This insurance helped farmers recover from sudden shocks by improving their capacities to re-arrange their activities during production seasons.

Since the outbreak of ASF in 2018, which affected the pork industry, local governments have paid more attention to producers' daily sanitation management. For example, the Centre for Animal Disease Control and Prevention in Pujiang County currently provides a range of disease prevention services to pig farmers, such as regular comprehensive disinfection and purchase of vaccines. The Agricultural Law-Enforcement Agency has taken charge of strict animal health supervision across the entire industrial chain of pig production. Government subsidies are provided for forced kills of infected pigs. To promote the long-term development of the industry, the county government has increased its efforts to propagate safe and modern pig-raising technologies for producers and has invested in infrastructure for the treatment, recycling and use of livestock waste. A direct positive effect that has been observed is the significant reduction in complaints about livestock pollution issues.

To improve the resilience of CRFS, in **distribution and market** availability (Table 1), strategies have been employed to improve the city region food distribution systems, for example the [Chengdu Food Product Market Plan \(2006-2020\)](#) has contributed to there being more complete local wholesaling and retailing market systems, which has increased the preventive and transformative capacities of the CRFS during shocks and stresses. Chengdu also has a [city food storage system](#) to be better prepared during periods of market supply shortages and increased prices.

Collectively, interviewees deemed these public initiatives as critical to improving the capacities of stakeholders and the resilience of CRFS and its response to shocks and stresses, even though they were unaware of the original triggers for the initiatives.

2. Multi-dimensional coordination facilitates collective actions during emergencies

Based on comments from the interviewees, approaches to facilitating multiple dimensions of coordination among CRFS stakeholders have been acknowledged, such as cross-region, cross-sector and public-private coordination and collaboration. These comprise a relatively comprehensive governance system, which is important for achieving CRFS resilience, especially during emergencies.

2.1 Cross-region coordination

Cross-region coordination occurs at both the provincial and metropolitan level. At the beginning of the COVID-19 outbreak in 2020, Sichuan province issued a policy to ensure the smooth transportation of agrifood and agricultural inputs across the province through the [Green Channel](#) measures. To guarantee sufficient and prompt food supply during emergencies, Chengdu [collaborated with a range of production sites](#) in other cities in the province (e.g. with Ganzi, A'ba, Liangshan, Panzhihua, etc.). At the metropolitan level, Chengdu also [collaborates with the three other cities in the metropolitan area](#) to coordinate the food supply systems. These actions help add flexibility and adaptability to the local food systems, and contribute to improving the resilience of the CRFS to shocks and stresses.

2.2 Cross-sector coordination

An initiative that was frequently mentioned during interviews was the Chengdu Action Plan to ensure daily supplies in response to large-scale epidemics, which was issued in 2022 by the municipal government (Table 2). The Action Plan was triggered by the continuous impacts of the COVID-19 outbreaks. The objective was to guarantee local food supply during the pandemic. Specifically, a [task force](#) was established in the municipal government. A Vice Mayor took the lead with a staff from 19 bureaus and offices, who were included as collaborative members. [Seven working groups](#) were set up, which were responsible for general coordination; market supply; guarantee of production; transportation; monitoring of markets; donations; and public guidance. As food supply is a task that requires support from a range of different sectors, the cross-sector approach that was applied to the Plan helped facilitate coordinated actions and information sharing between agriculture, transportation, commerce, health and publicity (Box 1). Despite these efforts, a delay in information sharing among the multiple dimensions was observed, as reported by the CRFS actors interviewed who joined the implementation plan, which suggests there is a need for improvement.

Table 1 Main food related initiatives in Chengdu mentioned by stakeholders (in chronological order)

Name	Year of commencing	Level of government	Description	Example of impact
Chengdu Food Product Market Plan (2006-2020)	2006	Municipal	The three-level wholesale market system and the retail market system proposed in the plan and put into practice. Specifically, the wholesale market system comprises large-scale integrated markets that distribute food from across the country to areas in west China, mid-scale district/county-level markets that supply food to nearby districts and counties, and small-scale local food markets that collect locally produced food that is often sold in a more specialized way. The retail market system covers farmers' markets, fresh food supermarkets and community grocery stores.	The food system structure allows for efficient food distribution and an improved food environment across the city as well as facilitates swift response to emergencies.
City food storage system	2007	Municipal	Chengdu has a range of long-term emergency storage warehouses for different types of food. Planned storage of grain, oil and meat is conducted for use during seasons of high-demand and unexpected shocks. The local vegetable and agricultural storage mechanisms for inputs are under development.	When the food supply fluctuates during emergencies, the reserve agricultural products (grain, oil, meat, etc.) can be released to the market to prevent supply shortages and to stabilize market prices.
Policy-support for agriculture insurance	2007	National; Provincial; Municipal	The aim is to allocate a pre-determined amount of the local financial budget to compensate for producers' economic losses during natural disasters and other incidents. Chengdu began to pilot the agriculture insurance initiative in 2007, and established a total of 21 types of insurance by 2018. Depending on the crops grown and/or livestock raised, producers need to pay 20 to 30% of the insurance premium; the rest is paid for by different levels of governments.	During all climate-related shocks mentioned by the interviewees, insurance was highlighted as having effectively mitigated their economic losses.
High-Standard Farmland Construction Initiative	2013	National; Provincial; Municipal	The main actions include land organization; soil improvement; construction of irrigation facilities and farm roads; forest protection; improvement of infrastructure for electricity; support for technology and optimization of management; Chengdu has also developed a series of corresponding policies and projects, and has observed a significant increase in farmland areas within the city year-by-year.	During the drought disasters of 2022, rice production in high-standard farmland areas greatly benefited from the well-established irrigation infrastructure and achieved even higher yields as rice grows well in higher temperatures, as noted by a producer during the focus group discussion. X
One Belt, Ten Parks and Hundred Districts Initiative	2022	Municipal	The initiative plans to establish one grain and oil industrial belt, ten grain and oil industrial parks and a hundred grain-cash crop combined industrial parks to support coordination of resources for the grain and oil production industries.	According to the government officer interviewed, this initiative is developed to promote grain production and improve self-sufficiency in grain-based food in Chengdu.

Table 2 Action framework for the epidemic plan (2022)

Capacity	Action
Preparation	<ul style="list-style-type: none">• Emergency distribution stations• Daily food storage for businesses, governments and society• Emergency staff organization in logistic services• Joint food supply mechanisms in collaboration with cities nearby
Response	<ul style="list-style-type: none">• Daily monitoring of market food availability and food supply enterprise status• Green channels for key food supply actors for health testing and transport• Adapted response measures specific to the various epidemic conditions and populations• Maintenance of markets and quality assurance• Coordination of food donations• Timely information sharing with the public
Recovery	<ul style="list-style-type: none">• Support to assistance• Reflections on working outcomes and potential improvements for future events

Box 1 Examples of cross-sector collaboration

In July 2022, when the Chenghua district announced lockdown measures, the district government immediately organized a preparation meeting in the afternoon. The municipal government then called for an emergency meeting on the night of the same day, gathering all relevant bureaus, offices; enterprises and organizations engaged in collaborating to secure daily supplies. The concrete actions required were agreed upon and how the different actors could coordinate and collaborate during implementation of the Epidemics Plan.

A representative from a fresh food retailer, who had participated in the midnight meeting and was satisfied with its outputs stated: *“In most cases, cross-sector collaboration works much better when actors know each other in person through a lively meeting, rather than everyone only hearing the names or seeing them with titles on a document.”*

At the operational level, one staff-member from each subdistrict office was assigned to coordinate residents’ daily supplies. Food supply businesses were able to coordinate with this individual if there were any problems, such as last-kilometre delivery problems and unexpected shop closure.

To guarantee local food transportation the municipal government issued a certificate for food supply businesses. This helped explain their significant roles in food security and obtained green-light support from working staff in all relevant sectors. A transport pass was also issued for staff and vehicles involved in the daily supply efforts, so they were permitted to travel across the city. On the first day of the citywide lockdown in August, upstream suppliers of the local food supply businesses were not included in the list to issue the transport pass, which could have constrained food supply in the city. The problem was fixed the following day through the coordination system established in the Plan.

To reduce the cost of labour and guarantee time sensitivity, an e-pass was used instead of a traditional paper pass, which permitted the efficient management of the pass-issuing list when the in and out flow of food suppliers was changing frequently.

Under the cross-sector framework of the Epidemics Plan, the Education Bureau also coordinated with institutions in the education systems on emergency actions. A list of food supply enterprises and organizations, as well as a list of central kitchens for prepared food, was provided to the institutions, so they could reach out in advance for emergency food purchases. Canteens in these institutions were required to monitor students’ food demands on a regular basis and make specific emergency plans under lockdown conditions that included temporary employment of kitchen workers, division of students’ dining time, dormitory meal delivery plan, etc. .

Box 2 Examples of cross-sector collaboration

An important measure that guaranteed residents access to food was the Fresh Food Bag initiative that distributed fundamental types of food to residents living in COVID-19 high-risk areas. The subdistrict offices in these areas were responsible for reporting households whose movement was restricted to higher-level government, based on which collaboration with the food supply enterprises was conducted to prepare fresh food bags for all households in these areas, with expenses covered by the government. Generally, the enterprises responsible for the preparation and transportation of the food bags, the subdistrict offices as well as community volunteers were responsible for mapping demand and home delivery arrangements. The subdistrict offices and residential committees also coordinated with food shops in the neighbourhood to arrange for mobile vegetable carts to assist residents when grocery shopping.

2.3 Public-private partnership

Another highlight of the Plan was the creation of a [public-private partnership mechanism](#) to gather joint efforts in the CRFS. A total of over 80 food supply enterprises, covering all nodes of the food systems, joined this partnership and agreed with the municipal government to take collective responsibility to secure the city's food supply during emergencies. In this mechanism, each side can make use of their respective advantages: the private sector, with its diversified supply chain resources, and the public sector with its capacity for multidimensional coordination, which effectively improved CRFS resilience during the two waves of COVID-19 in 2022 in Chengdu (Box 2).

2.4 Supply chain coordination

Collective action between upstream and downstream actors and practitioners in the food supply chain was frequently observed, which helped mitigate disruptions in the food chain during emergencies.

In face of rapidly increased demands on the consumption side, it is critical that retailers are able to swiftly adjust their restocking plan to ensure sufficient availability, which largely depends on collaboration with upstream suppliers. Some retailers interviewed said their [long-term collaborators are able to increase restocking](#) flexibly and promptly, while most retailers stated the [diversity of their upstream](#)

[suppliers](#) permitted them to coordinate the delivery of more products from different sources. Another business model that has emerged in recent years is [direct collaboration between retailers and production sites](#) (producers or producer organizations), which is advantageous as risks are reduced in longer supply chains, especially during emergencies, and it is easier to manage food quality.

Other typical coordinating activities among wholesale markets, as food trading platforms, and food merchants who sell food products through the platforms. The two large-scale wholesale markets in Chengdu play a critical role in regional food distribution and the municipal government has made a partial investment, the representatives interviewed stressed that their mandates maintained the stability of both businesses and the market.

[Comprehensive emergency action plans](#) have existed for many years, and were developed for these markets to improve response during seasons of high-demand and shock events. These plans are continuously improved, especially for COVID-19 situations. These plans normally cover data monitoring of food production areas and upstream suppliers; listing of priority food varieties; collaboration with priority food merchants for responsible supply and price guarantees and preparation of alternative market spaces during extreme situations such as the forced closure of existing markets (Box 3).

Box 3 Examples on how the coordination between wholesale market and merchants works

A total of 75 vegetables were identified as basic food to be supplied by the market, where ten vegetables with a longer shelf-life were identified as the highest priority varieties to be supplied as basic food during emergencies. The market collaborates with 50 merchants to distribute the ten highest priority vegetable varieties (five merchants for each variety), who agreed to guarantee the stable supply of these food products during emergencies through responsible transportation, storage, price control and shared database development. The market also conducts close monitoring of the availability of stock, sales status and daily food prices, based on which further adjustments can be made to maintain the stability of the food flow. According to the Baijia wholesale market, there were plans to transfer the highest priority food merchants to alternative market locations so as to ensure continuous operations under extreme situations such as the forced closing of the market.

Closing gaps to ensure a more resilient city region food system in Chengdu

Building on the collected interview data, several gaps were identified during discussions among the CRFS actors and researchers, which led to recommendations for a more resilient CRFS in Chengdu (Table 3).

The first key gap recognized by the producers, considered the most vulnerable to the frequent climate-related shocks and stresses, is the insufficiency of modern agricultural infrastructure and protected agriculture facilities. This will require accelerated strengthening of long-term production capacity, given the increasing impacts of climate change observed. Collective efforts are needed from research and development in the laboratory to the transfer of technology in the field, to boost the process of modernization of local agricultural production and, in turn, facilitate the increase of preventive and transformative capacities to achieve CRFS resilience.

Second, although a number of lessons can be learned in terms of multidimensional coordination from the case of Chengdu, there is still much room for improvement in terms of coordination tools and measures covering specific issues at the grassroots level. For example, the problem of the asymmetry of information was

mentioned during the focus group discussion, which caused unreasonable lockdown of some grocery stores during the COVID-19 outbreak and cost much negotiation time as well as food waste.

Requests were also made for information sharing among different actors, such as between retailers and producers to create shorter supply chains, and between consumers and suppliers for direct food buying during emergencies. These situations require collaboration between the public and private sector to establish tools such as digital platforms to ensure the efficient flow of information, which can improve the anticipated, absorptive, adaptive, and transformative resilience capacities of the local food systems.

Furthermore, the focus group discussions concluded that better planning and resource mobilization are required at the governmental level. This is reflected in the current gaps in cross-province collaboration for emergency food assistance, spatial planning for food distribution sites, support to agricultural worker recruitment and access to finance for food supply businesses. Better systemic strategies are required for CRFS development and corresponding policies to address the problems identified above in the short-, medium- and long-term action plans, with a view to transformative strengthening of the resilience of the CRFS.

Table 3 City region food system gaps, and recommended actions identified during interviews and focus group discussions

Identified gap	City region food system node	Recommended action	City region food system actor involved	Resilience capacity to be improved
Insufficiency in modern agricultural infrastructure and protected agriculture facilities	Production	To accelerate implementation of the high-standard farmland construction initiative and increase coverage of high-standard farmland in Chengdu, through well-organized budget allocation and close monitoring of existing and future high-standard farmland	Municipal and district and county government	Preventive and transformative capacities
		To establish research-industry cooperation platform (based on the development of Chengdu National Science and Technology Innovation Center for Modern Agricultural Industry), support connection of different actors involved in innovative activities and promote the transfer of science and technology	Municipal and district and county government	Preventive and transformative capacities
		To adjust the focus of R&D and increase fund allocation for protected agriculture and facility development projects	Research institutions, technology companies	Preventive and transformative capacities
Lack of well-developed coordination tools and concrete measures to coordinate on-the-ground practices during emergency events	Production, distribution, retailing, consumption	To establish CRFS database that incorporates data on local food chains and relevant actors to enable digitized monitoring and efficient connections to multistakeholders	Municipal government, private sector entities	Preventive, anticipative, absorptive, adaptive and transformative capacities
		To develop public-owned online emergency food shopping tools that match diverse food suppliers with consumers' demands and assist with direct purchase of food	Municipal government, private sector entities, consumers	Absorptive and adaptive capacities
		To develop specific tools to guide different concrete practices that are in line with municipal emergency plans and improve cross-level and cross-sector information sharing mechanisms	Municipal and county and district government, private sector entities	Anticipative, absorptive and adaptive capacities
Insufficiency in systemic planning and resource mobilization for CRFS development	Production, processing, distribution, retailing	To collaborate with other provinces and establish cross-province emergency food assistance mechanisms	Provincial and municipal government	Absorptive and adaptive capacities
		To support recruitment of youth talent and training activities for agrifood workers	Municipal and county and district government, private sector entities	Preventive, anticipative, absorptive, adaptive and transformative capacities
		To support access to finance for food supply businesses such as for processing, storage and logistics industries	Municipal and county and district government, private sector entities	Preventive, absorptive, adaptive and transformative capacities
		To develop local food system strategies with multiple scales of food distribution sites planned spatially and with CRFS resilience as one of the pillars in short-, medium- and long-term action plans	Municipal and county and district government	Preventive, anticipative, absorptive, adaptive and transformative capacities