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# Food Security and COVID-19: Impacts and Resilience in Singapore

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Across the world, the COVID-19 pandemic has disrupted food supply chains and threatened food security. Singapore is highly dependent on food imports and has an open economy that exposes it to volatile global markets, so it is acutely vulnerable to the effects of the pandemic on other countries, the effectiveness of measures taken by foreign governments to combat the spread of the virus and overall disruptions of international trade links. Proactive and reactive steps have been taken to protect Singapore's food supply chains against the adverse impacts of COVID-19. In this paper, we discuss food security in the city state, the impacts of COVID-19 in the population, the local production, and imports from two main trade partners: Malaysia and China. We conclude by acknowledging the complexity of achieving food security under the very difficult circumstances.

**Keywords: food security, COVID-19, Singapore, Malaysia, China, resilience**

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## INTRODUCTION

The COVID-19 virus, as named by the World Health Organization on 11 February 2020, spread rapidly across the world with serious social and economic consequences. At the height of the pandemic across the world, international borders closed abruptly and most of the world was forced into some form of social distancing with movement restrictions at national and international levels (Laborde et al., 2020). What started as a health crisis, has had numerous negative impacts on the world economy, such as that on the global food and agriculture sector. Measures to contain the spread of the virus in many countries inadvertently disrupted the supply of agri-food products to markets and consumers both within and across countries (OECD, 2020). This created numerous challenges with regards to food production and demand, adversely affecting food availability in several countries.

According to FAO (2020), despite the global economic downturn arising from the COVID-19 pandemic, global agricultural production has been less affected. Global supplies are ample: supplies of staple crops are large, production prospects are favourable, and cereal stocks are expected to reach their third highest level on record. In general, disruptions have been in terms of production, processing, and marketing due to the outbreak and containment efforts, but also due to shifts in consumer demand. These disruptions have led to increased prices and stock-outs of food products (ILO, 2020).

Globally, it is estimated that 1.3 billion people are predominantly fed through international trade (Wolff, 2020) and more countries are reliant on food imports than ever before. International food security is dependent on functional global supply chains, which are characterised by smooth flow

of agricultural products and food from the producer to the end consumer. During the COVID-19 pandemic, logistics in food value chains such as transportation, warehousing, procurement, packaging, and inventory management have been disrupted, adversely impacting the quantity of food available and its quality, freshness, safety, access to markets, and affordability (FAO, 2020).

There has also been a major change in the structure of demand for food globally. Not only was there a collapse in demand from restaurants, hotels, and catering services as well as the closure of some open markets (FAO, 2020), but also a surge in consumer demand faced by supermarkets, neighbourhood grocers and grocery-related e-commerce channels (OECD, 2020; Coluccia et al., 2021).

The aim in our paper is to investigate the impacts of COVID-19 in Singapore's food security. Our research questions are, what have been the policies and decisions taken by the government to support the population in general during the first months of the pandemic, mainly the most vulnerable, increase local food production, address international supply chain disruptions, and build a more resilience system for future events?

Singapore is characterised for developing policies and taking decisions in a framework of dynamic governance that considers long-term planning and preparedness for change (Neo and Chen, 2007). The city state has also developed a whole-of-government approach in crisis management, whereby an inter-agency coordination platform is established across the Singapore Public Service to address security threats but also regular cross-agency coordination. In this task force, senior representatives from all ministries work together and report to the elected leadership for political direction (Low, 2016). It has been this culture of long-term planning, preparedness for change and the whole-of-government response, that have been essential to respond to the numerous challenges posed by COVID-19.

At the beginning of the pandemic, policymakers in Singapore, as well as in the rest of the world, took decisions without full knowledge or understanding of COVID-19 and its socio-economic consequences either locally or globally. As it is the case of humanitarian actions, numerous decisions were taken under pressure and uncertainty, many of them with significant consequences (Clarke and Campbell, 2020).

The rest of the paper proceeds as follows. We first describe our methodology and approach. We then present the food security strategies Singapore has developed over the years, followed by an account of the impacts the COVID-19 pandemic had in the city state during the February to July period in 2020, as well as the policies and decisions that were taken to mitigate impacts on food supply chains. We also analyse vulnerabilities of local production during this period, the initiatives public agencies developed to reduce risks and ameliorate inevitable impacts for vulnerable populations as well as protection measures. We also discuss the effects of COVID-19 in two main trade partners: Malaysia and China, and the potential impacts in terms of food security in Singapore. We conclude by acknowledging that the policies of the city state to improve food security have been effective but that the ongoing pandemic requires their continuous review because of reliance on external sources of food.

## METHODOLOGY AND APPROACH

This paper is based in qualitative research and extensive literature review and analysis. It elicits rich details on the situation in Singapore during the first months of the pandemic in 2020; the support provided to increase local food production; strategies to protect individuals that were already food insecure; and policies and decisions taken with the objective to mitigate the impacts of international food supply chain disruptions.

Documents reviewed included academic literature, policy documents and annual reports of government agencies. Academic literature was obtained through known accredited databases like Scopus and Web of Science. Regarding policy documents, we examined Hansard (Official Reports on Parliamentary Debates) published by the Singapore Parliament, to understand the political attention accorded to the impacts of COVID-19 as the situation was evolving, and the associated policy responses. Reports from the Singapore Food Agency, the national authority responsible for ensuring and securing a supply of safe food, and its predecessor, the Agri-Food and Veterinary Authority (AVA)[1], were essential to understand policies for food security in the city state. Finally, we relied heavily on news reports as they were the sources that provided the latest contextual information on the global situation as it was unfolding.

We follow a case study approach. We selected it to gain concrete, contextual, in-depth knowledge about the specific real-world subject (Yin, 2017). It is also the appropriate method to explore key characteristics, meanings, and implications of the case to identify the "how" and "why" questions pertaining to contemporary phenomena in a real-world context. We acknowledge its limitations, which are those inherent to qualitative case study analysis in the sense that they are case specific, and findings cannot be generalised.

The study is based on secondary sources of data and information. This was very effective as a means of gathering information from different parts of the world and from numerous sources as the situation regarding COVID-19 was unfolding. Document analysis was also used as a means of triangulation to seek convergence and corroboration and reduce biases (Bowen, 2009), one of the main limitations of using secondary sources of information.

The study is especially relevant because Singapore imports ∼90% of the food the population consumes, making it vulnerable to international supply chain disruptions. Its novelty is the analysis of vulnerability of local production during the pandemic.

## FOOD SECURITY IN SINGAPORE

Singapore is a small island state located in Southeast Asia at the southern end of the Malay peninsula. It has limited natural resources, with only 1% of land available for food production.

[1]AVA was a statutory board from 2000 to 2019 under the Ministry of National Development that was responsible for regulating food safety, safeguarding animal and plant health, and facilitating the agri-food and fisheries trade sectors.

The food security of its 5.7 million residents depends on both complex global supply chains, which are responsible for over 90% of local food consumption, and limited local food production (Ludher, 2016; Singapore Government, 2020). The city state is inherently vulnerable to fluctuations in food supply arising from price volatility, food safety problems in the countries of origin, protectionist food-producing countries prioritising their own needs over international commitments, emerging trends such as climate change, and black swan events like this global pandemic (Singapore Parliament, 2021). Resulting short-term impacts could include temporary lack of certain food supplies, increased competition with major global buyers, and price increases. Long-term impacts could be unavailability of specific food supplies, increased competition over increasingly tight food supplies, and higher food prices.

For the most part, and despite the island country's high food import dependency and lack of a hinterland, the city state has been able to achieve food security by implementing three core strategies (Teng, 2013, 2020; Singapore Food Agency, 2019; Ng, 2020). First, diversified sources of imports from 170 countries and regions of high-quality supply of food. A strong network of trade partnerships, such as ASEAN Plus Three (Southeast Asia-East Asia regional co-operation) (ASEAN, 2017), and Free Trade Agreements with several countries also ensures that food supply chain remains reliable and adaptive in the event of localised disruptions (MTI, 2020b).

Second, local production provides buffer supply in the event of overseas supply disruptions. To assist local farmers in improving yield and productivity, several funds have been established along the years. For example, a S$30 million Food Fund established in 2009, and reinforced in 2011 and 2013, to support food diversification efforts and productivity by developing local farm capabilities. In 2014, a S$63 million Agriculture Productivity Fund replaced the Food Fund to support innovation and the adoption of new technologies (FAO, 2013/14). Support has also been extended to food and non-food farms. To fully encourage investments in farming, the government acknowledged the need to revise some policies. For example, land tenures for agriculture were lengthened if such land is not being planned for development to encourage greater investments by farmers (Parliament of Singapore, 2016).

In 2019, the government announced its "30 by 30" goal to increase local production to meet 30% of Singapore's nutritional needs with <1% of its land area by 2030 (Singapore Food Agency, 2020; Singapore Parliament, 2020a). To this end, the government has implemented a host of regulatory and financial measures. First, the Singapore Food Agency (SFA), a new agency that would focus solely on "ensuring and securing supply of safe food" was established, prioritising food security. SFA has been developing and awarding agricultural land to companies, including large arable plots in the more rural area of Singapore known as Lim Chu Kang (Ng, 2020) and small unorthodox urban spaces like car park rooftops (AVA, 2018). This has been aided by ongoing collaborative efforts with farm operators and the Singapore Agri-Food Enterprises Federation to improve regulations (Singapore Parliament, 2020a). The government has invested heavily in local farms to build capacity and innovate through funding schemes such as the S$63 million Agriculture Productivity Fund (Singapore Food Agency, 2020) and the Startup SG Equity Scheme for agri-technology (Singapore Parliament, 2020a). They have established the new Agri-Food Innovation Park. There has been extensive research and development investment in agriculture, such as in vertical farming and identification of alternative protein sources (Kwiatkowski and Stringer, 2020).

Third, overseas agricultural investment and industry development is provided to local companies to export food, allowing them to expand in third countries. This strategy also supplements local production with food imports efforts while minimising exposure to volatile supple chains (Tortajada and Zhang, 2016).

## Food Availability, Economic and Physical Accessibility, and Food Utilisation

Regarding food availability, the city state maintains an essential food item stockpile of staples and proteins. For essential items not in the national stockpile, suppliers are either encouraged or mandated to take actions to ensure business continuity, such as with diversified sourcing, contracts, or buffer stockpiles. Specifically, for rice, the Singapore government requires importers to hold stocks of ∼2 months' worth of rice (Caballero-Anthony et al., 2020). In the case of other essential commodities, such as vegetables, fish and meat, importers have avenues through which they can request for government support to maintain sufficient stocks, such as by keeping bilateral trade lines open (Caballero-Anthony et al., 2020).

In terms of economic accessibility, Singaporeans benefit from having the second most affordable food in the world and consistently low inflation at 19.2% from 2010 to 2019, as reported by the Global Food Security Index (The Economist, 2020). With an average income that is five times the global average, the population ranks safely above the global poverty line and typically spends only one-fifth of their monthly household expenditure on food (Department of Statistics Singapore, 2018).

For food utilisation, despite the availability and accessibility of healthy food, the Global Food Security Index ranks Singapore 36th in the world for food quality and safety due to the unhealthy nature of the average diet, heavy on starchy food and lacking in essential nutrients and protein (The Economist, 2020).

## Vulnerable Households

Despite high levels of overall food security in Singapore, from 2016 to 2018, 4.1% of Singaporeans were estimated to experience moderate to severe food insecurity (FAO, 2019). Reasons for persistent food insecurity include the inability to afford food, difficulty in cooking or purchasing food due to health or mobility reasons, time constraints, under-coordination of resources leading to overserved, and underserved vulnerable groups and certain bureaucratic barriers to getting assistance (Glendinning et al., 2018).

Support from the government and non-governmental organisations compensates for the inherent food insecurity of these groups to some extent. ComCare (financial assistance for poor Singaporeans for basic living expenses, inclusive of

food-related expenditures) and the Silver Support Scheme (provision of a quarterly cash supplement to seniors who had low incomes during their working years and now have less in their retirement) are offered as broader social safety nets that protect vulnerable individuals (Goh et al., 2020). Furthermore, there are at least 125 non-governmental organisations that provide food support (Heng, 2020).

## EFFECTS OF THE PANDEMIC ON FOOD SECURITY

The pandemic has posed serious challenges to each segment of food supply chain in Singapore: food imports, local production, retail grocery markets, food and beverage services, and support for vulnerable individuals. This has been the case not only in Singapore but in most countries if not all of them (Mardones et al., 2020; Coluccia et al., 2021).

In early 2020, when the coronavirus that was first detected in Wuhan started affecting Singapore, the government decided to follow the whole-of-government approach in crisis management mentioned before and established the "Multi-Ministry Taskforce on Wuhan Coronavirus" with representatives from all ministries at the ministerial level. Their tasks were "to direct the national whole-of-government response to the novel coronavirus outbreak; coordinate the community response to protect Singaporeans and stay vigilant against the spread of the disease; and work with the international community to respond to the outbreak" (Singapore Ministry of Health, n.d). The task force has been essential to coordinate all government responses and to keep the population informed. Among the many decisions that have since been taken by the Multi-Ministry Task Force are those on food security. The task force is operational at the time of writing this paper.

The following sections of the paper discuss the policies and decisions taken between February and July 2020 to address the impact of the pandemic on local production, food insecure individuals, and food imports with focus on specific food items.

### Local Production

Imports are the main source of food for Singapore, and local production of vegetables, hen eggs and fish supplement them (Ng, 2020). Increasing domestic capabilities in food production is strategic to protect Singapore's food security, reducing dependence on international trade and allowing the government to better control food availability.

The onset of the COVID-19 pandemic accelerated government efforts to develop local production capabilities. In response, SFA released the tender for additional urban spaces for farming, including the rooftops of multi-storey car parks (Liu, 2020), and expects to identify and free up more. There has also been massive financial support, including the new $30 million 30 × 30 Express Grant, to support expansion of local farms, sustainable and resilient farming practises, and innovation with agri-technology (Singapore Food Agency, 2020). These efforts were planned before the pandemic with the objective to strengthen food security and will go a long way in building the commercial scalability of Singapore's agricultural industry.

Small-scale initiatives by the government have involved expanding community gardens and implementing schemes to empower individuals to grow their own food. Another public agency, the National Parks Board (NParks), intends to double and triple the number of community gardening spaces and allotment gardens respectively (Begum, 2020), supporting casual gardeners in their efforts to take greater ownership of producing their food. NParks has distributed vegetable seeds to interested households under the Gardening with Edibles initiative so they could grow their own produce (Begum, 2020). While these initiatives are unlikely to have much impact in terms of the scale of production, they may improve local perceptions of food security as individuals are able to produce their own food to some extent.

There have also been ongoing efforts to promote awareness of local produce, with joint efforts by SFA and Ministry of Sustainability and the Environment on the 2020 Singapore Food Storey campaign (Ministry of the Environment and Water Resources Singapore, 2020). Local produce on retail shelves is labelled accordingly, with further efforts taken to advertise it. As a nod to the increasing presence of online channels, SFA, with the Singapore Agro-Food Enterprises Federation, organised an online farmers' market on a popular online platform for groceries to expand the reach of local farms (Singapore Food Agency, 2019).

One key limitation of efforts to scale up local production is affordability. Much of Singapore's locally produced food is achieved through the application of technology to limited land (Singapore Food Agency, 2020). In combination with higher costs for labour and land, these production costs often translate into higher prices (Elangovan, 2020). With Singapore's connectivity with the rest of the world, imports are both cheaper and more recognisable by the end consumer. For example, local producers can scale up production of eggs by 60%, but they do not believe that there will be demand because eggs from Malaysia and Ukraine are typically 20% cheaper (Singapore Food Agency, 2020).

### Protecting Individuals With Food Insecurity

Some of the most important impacts of the pandemic have been in terms of affected livelihoods and increasing prices of food.

The circuit breaker period (as lockdown is known in Singapore) and consequent measures severely affected incomes and savings, threatening the ability of affected individuals and households to afford sufficient and healthy food. To illustrate, half of the respondents in an OCBC survey reported wage cuts, mandatory no-pay leave, or a reduction in commission-based earnings by May 2020 (Wei, 2020). Two-thirds of working Singaporeans also reported insufficient savings to buffer against a reduction in earnings for more than six months, with one-fifth reporting that their savings have decreased by more than 20% (Wei, 2020).

Food inflation exacerbates the difficulties faced by vulnerable households. The Monetary Authority of Singapore (MAS)

reported food inflation of 2.2% as of July 2020, despite having a negative core inflation of -0.4% (Department of Statistics Singapore, 2020a). This was driven mostly by the 2.2% inflation of food items.

Lower-income households, who already struggle with economic access to food and food utilisation, were disproportionately affected. On average, the poorest 27,000 households in Singapore have savings amounting to S$246 and consistently spend more than what they earn from regular sources of income (Department of Statistics Singapore, 2018). Notably, over a third of these households are headed by individuals aged 65 years and over as of 2017/2018. The legal age of retirement is 65 years in Singapore, which may account for the lower regular receipts of funds. Any disruption to regular sources of income would likely directly impact their already tenuous ability to afford food.

The poorest Singaporean households spend a significantly larger proportion of their income on food, 23%, as compared to the richest households, 17.7% (Department of Statistics Singapore, 2020b). Food inflation is likely to disproportionately affect the economic accessibility of food for these vulnerable households. To illustrate, total inflation across the first half of 2020 for the poorest fifth of households was slightly higher at 0% as compared to -0.2% for the average household, driven in part by higher food inflation of 2% as compared to the average of 1.9% (Department of Statistics Singapore, 2020b). It is therefore not surprising that the proportion of food insecure individuals and the extent of food insecurity for those already vulnerable increased in the first half of 2020.

Food charities saw a significant increase in requests for help from vulnerable households and individuals. They also faced many difficulties in serving their target groups due to fewer donations and low volunteer turnout, possibly because of the usual donors reacting to economic difficulties caused by the pandemic (Loh, 2020).

To address rising food insecurity and preserve the economic accessibility of food, the government has set aside a significant amount of funds that will directly support those who have lost their jobs or face a sharp decrease in income as well as all adult Singaporeans (Singapore Parliament, 2020b). The government also allocated S$20 million to the Community Development Councils to support 400 thousand lower income households to purchase food from certain hawkers (traditional food sellers) and shops island wide.

Existing measures to support low-income and vulnerable groups with expenses, such as ComCare, were also made available and more accessible (Singapore Parliament, 2020b). More Singaporeans began to qualify for these government welfare schemes, such as the ComCare Interim Assistance scheme for those with urgent need for financial assistance for <3 months and the ComCare Short-to-Medium-Term Assistance scheme for those with financial difficulties.

## Food Imports

Because importing food is the main means by which Singapore ensures food availability, any disruption of international trade threatens its physical and economic access to food. Some of the main import partners of Singapore are Malaysia, China, Brazil, and Australia, though some food items are produced domestically (AVA, 2020). The following section provides an overview of international supply chain disruptions with Malaysia and China, essential food trade partners for specific commodities.

### International Supply Chain Disruptions and Their Impacts

As a result of COVID-19, many countries have imposed different types of temporary export measures such as export restrictions and liberalisations. Affected products include personal protection equipment (e.g. masks, gloves), pharmaceutic products, hand sanitizer and food, among others (ITC Market Access Map, 2021) (**Figure 1**). Supply chain disruptions and government decisions to restrict exports or stockpile commodities have raised concerns as they can have serious impacts in terms of food security. Singapore reached out to its trade partners very quickly, and called for international commitments to ensure supply chain connectivity (MTI, 2020a; Neo, 2020; Singapore Parliament, 2020c).

Even then, COVID-19 challenged the efficacy of the city state's diversification and stockpiling strategies. While the government took both pre-emptive and reactive measures to combat disruptions of food imports, the island nation was not fully sheltered from disruptions of international supply chains.

Prices of imported foods increased, affecting food prices for end consumers. According to the Department of Statistics Import Price Index of May 2020, monthly prices of imported food items were consistently 3–4% higher in February to May 2020 than in the same period the year before (Department of Statistics Singapore, 2020a). As the coronavirus situation continued worsening globally, prices continued rising. In July 2020, the prices of imported food and live animals were 0.3% higher than in June (Department of Statistics Singapore, 2020a). To some extent, these higher prices were absorbed by retailers and food service establishments, before being translated into food inflation of 2.2% year-on-year for end consumers in July (Wei, 2020). Specifically, this includes an increase in the prices of basic staples, like bread and cereals, livestock and a variety of other essential food items (Trading Economics, 2020). Among food servicing services, inflation averaging above 1% was observed for all components: fast-food, hawker food prices, catered food, and restaurant food (Trading Economics, 2020). Higher prices have consequently reduced the economic accessibility of food. For example, in the last quarter of 2020, the Consumer Price Index (CPI) for food in Singapore was 101.9. This was an increase by 1.9 index points compared to the base year 2019 (**Figure 2**).

In 2020, between the first and second quarters, food index points were 0.8 index points lower. By the second quarter of 2021, there had been an increase of 1.5 index points compared to the first quarter in 2020 (**Figure 3**).

Following is an analysis of the situation in Malaysia and China in terms of food security due to COVID-19.

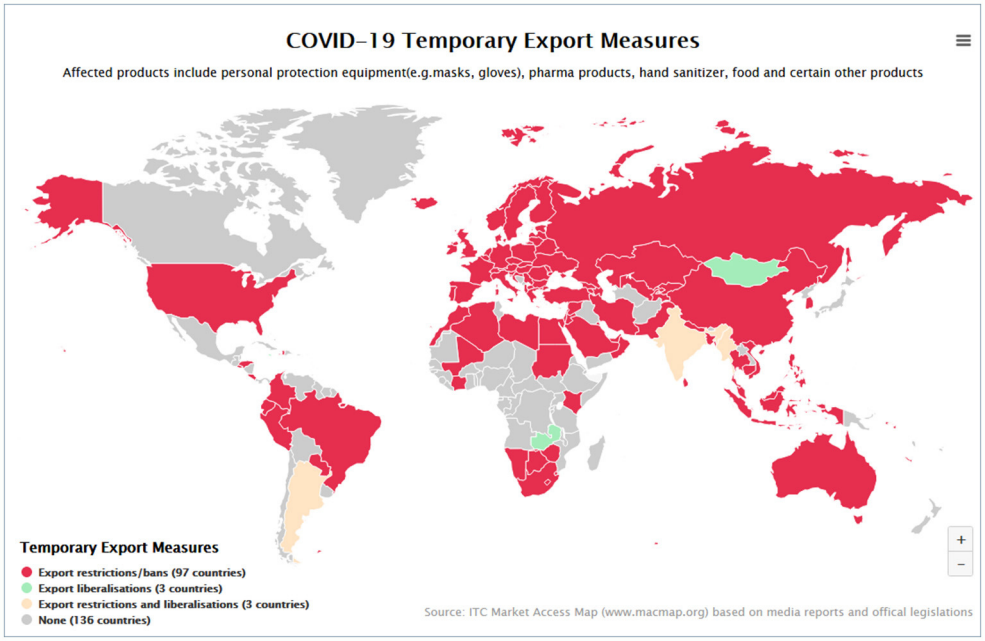


**FIGURE 1 |** COVID-19 temporary export measures (Source: ITC Market Access Map).

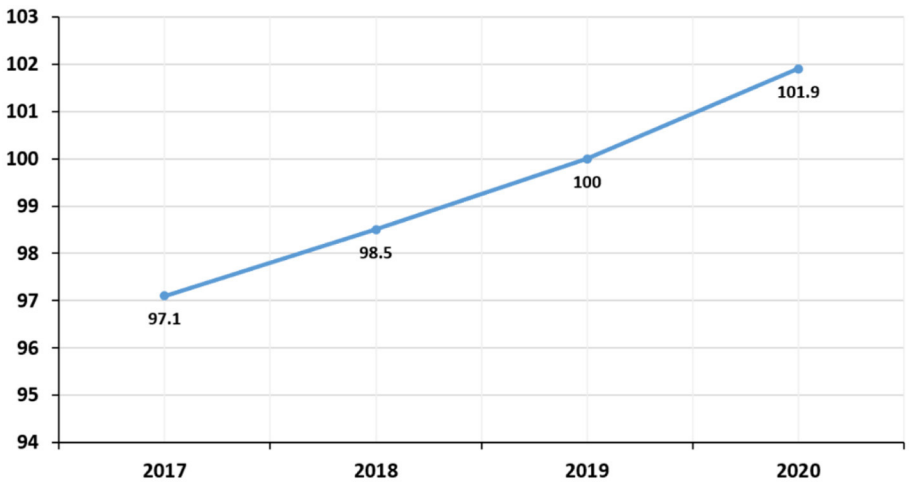


**FIGURE 2 |** Consumer Price Index (CPI) for food in Singapore, 2017–2020. Source: Singapore Department of Statistics, Ministry of Trade and Industry (MTI), Statistical Appendix, Consumer Price Index. https://www.mti.gov.sg/-/media/MTI/Resources/Economic-Survey-of-Singapore/2021/Economic-Survey-of-Singapore-Second-Quarter-2021/A3_1_2Q21_.xlsx.

## Main Food Import Partners

Some of the most important food import partners for Singapore are Malaysia and China, especially in volume terms. Changes in food exports have the potential to affect Singapore.

### *Malaysia*

With its proximity and strong ties to Singapore, Malaysia is the largest food exporter to the island nation, exporting over US$2.4 billion of food in 2018. Singapore is especially dependent on Malaysia for vegetables, fruit, eggs, and poultry. In 2018, the city state imported US$423 million of animal products and US$862 million of vegetables (WITS, 2018).

*Eggs.* On 18 March 2020, Malaysia implemented a strict movement control order (MCO), which closed many non-essential industries (Perimbanayagam, 2020), and the egg supply chain was threatened by disruption of its production inputs. The packaging and sawmill industries are not considered essential, but then egg producers may face shortages of egg trays and

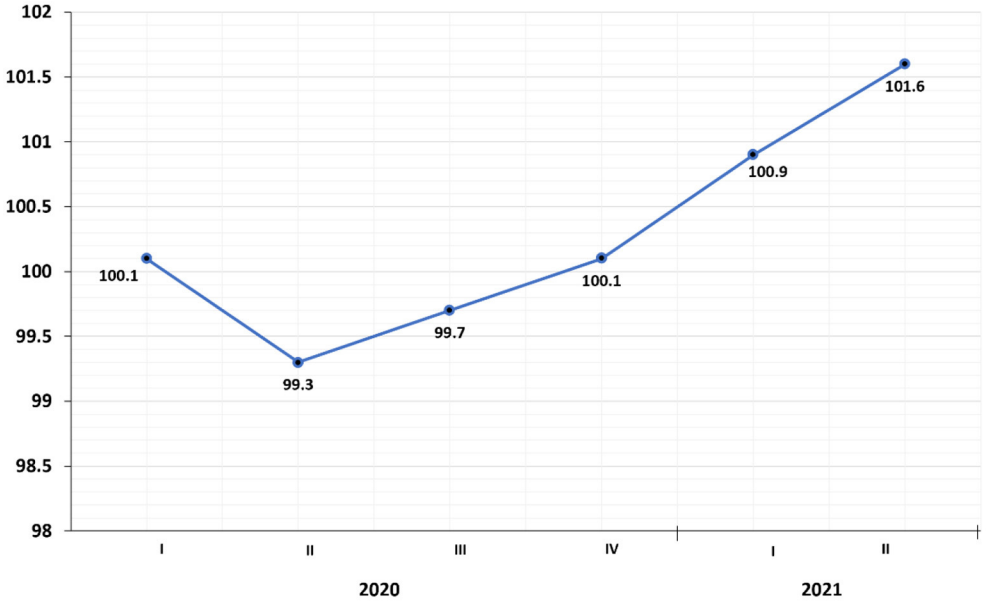


**FIGURE 3 |** Consumer Price Index (CPI) for food in Singapore, 2020–2021. Source: Singapore Department of Statistics, Ministry of Trade and Industry (MTI), Statistical Appendix, Consumer Price Index. https://www.mti.gov.sg/-/media/MTI/Resources/Economic-Survey-of-Singapore/2021/Economic-Survey-of-Singapore-Second-Quarter-2021/A3_1_2Q21_.xlsx.

sawdust (used to keep chicks warm) (EdgeProp News, 2020). Furthermore, in the initial phase of the MCO, difficulties arose in transportation and delivery due to unclear communication. These disruptions hampered Malaysia's local egg supply chain to some extent. For example, suppliers reported the need to reject domestic orders (Shaari, 2020) or adjust delivery times to ensure that eggs could be delivered to smaller towns in Malaysia (Perimbanayagam, 2020).

Singapore's egg supply chain was also temporarily affected by the MCO. While the availability of eggs was not significantly disrupted, the price for end consumers increased 7.3% from March to April 2020, representing a 6.4% price increase over the same period in 2019 (Department of Statistics Singapore, 2020b). Any disruption of egg imports from Malaysia would undoubtedly affect Singapore in the short term regarding both food supply and prices. Singapore imports most of its eggs (72%) from Malaysia, buffered only by the 24% produced locally and minimal imports from other countries, including Ukraine and Thailand (Ng, 2020). Any disruptions of the egg supply chain from Malaysia cannot be quickly compensated for, thus the spike in prices. Alternatives to Malaysian eggs are typically more expensive or require long shipping times (Ong, 2020) and scaling up domestic production would take at least six months (Teh, 2018). Furthermore, Singapore does not have a national stockpile of eggs but depends on local companies to maintain their own (Ng, 2020), constraining the flexibility of government response.

*Fresh Produce.* The total value of fruits and vegetables imported into Singapore in 2019 was ∼S$2billion (The Star Online, 2020) of which Malaysia, Singapore's largest partner for fresh produce, supplied 39% of the fruit and 41% of the vegetables (Ng, 2020). Malaysia's fresh produce supply chain is complex, with many small farms, diverse distribution models and several types of retailers (Arshad, 2012). Conventional supply chains involve small farms that supply their produce to wholesalers, who manage packaging, processing, exports, and local distribution (Man et al., 2009), although these supply chains are unstable and often duplicative (Arshad, 2012). Food products are typically unbranded and sold in bulk to wholesalers (Arshad, 2012).

Although the food supply sector and related essential services were technically allowed to operate under the MCO, many produce markets and stalls had to close due to government restrictions. COVID-19 outbreaks in wholesale markets in Kuala Lumpur and Selangor exacerbated the disruption of retail sales, as several large markets, including the largest wholesale market in Kuala Lumpur, were closed for safety concerns (The Star/Asia News Network, 2020).

Unable to market fresh fruits and vegetables that were ready for harvesting, farmers faced a difficult decision of either leaving it to rot or disposing of it. It is estimated that during the MCO 30–50% of fruit production and 20–30% of vegetables were wasted (The Star Online, 2020). Despite the domestic supply glut, the Kuala Lumpur Vegetable Wholesalers Association predicted that the closure of wholesale markets would cause vegetable prices to increase by 30–70% (The Star/Asia News Network, 2020).

Other problems arising from the MCO pertain to the difficulty farmers face in securing inputs for production, including labour, packing materials, machinery, and fertiliser (The Star Online, 2020). The closure of shops that serve the transportation industry also contributed to logistical disruptions as transportation

options for fresh produce were constricted (The Star Online, 2020).

As with eggs, fresh produce remains available but at a higher cost for some products. The chairman of the Singapore Fruits and Vegetables Importers and Exporters Association said he expected no significant disruption of the fresh fruits and vegetables supply chains from Malaysia (Heng, 2020). The seasonally adjusted prices of fresh fruits remained relatively stable over the first half of 2020 (Department of Statistics Singapore, 2020b), but vegetables became more expensive. The seasonally adjusted prices of root vegetables increased steadily to peak in June at a 6% year-on-year price increment (Department of Statistics Singapore, 2020b). The largest price increase for vegetables occurred between March and April 2020, with a 2.1% increase (Department of Statistics Singapore, 2020b), suggesting that the MCO was a significant contributing factor. However, Singapore has a much more diversified supply chain for vegetables than for eggs. Any impact on the affordability of vegetables for the consumer cannot be solely attributed to disruptions of the supply from Malaysia, since the island nation also imports vegetables from other countries (including China). Thus far, Singapore's food imports from Malaysia remained relatively stable, for two key reasons.

First, both Singapore and Malaysia recognised the importance of maintaining stable trade flows despite the COVID-19 outbreak. Both countries were prompt in establishing the Singapore-Malaysia Special Working Committee on COVID-19, which oversees and coordinates the "safe and sustainable movement of people, goods and services" between the two countries (Ministry of Foreign Affairs Singapore, 2020). Both countries actively affirmed their commitment to maintaining connectivity with key trade partners and participated in the ASEAN Summit and ASEAN Plus Three Special Summit on COVID-19 to enhance regional cooperation on food security and food supply chains (Neo, 2020).

In the first half of 2020, there were news of very large supply gluts and of fewer trucks transporting food into Singapore from Malaysia (Lim, 2020) but the impact on food availability and prices for Singaporean consumers were minimal. This may be because Singapore has been able to release food items from its stockpiles to counteract any supply shocks and rely on increased local production to support any import shortfalls. With its many close international trade relations, Singapore may also have been able to increase the quantity of food imports from other countries. For example, just two days after fears of food shortages were stoked by Malaysia's MCO, 300 thousand eggs were imported from Thailand (Ng, 2020).

### *China*

*Fresh Produce.* China produces over half of the world's vegetables and more than a fifth of the world's fruits (Marterer, 2015). Most of this is intended for domestic consumption; still, as of 2019, China was the world's sixth-largest exporter of all agri-food commodities (Brodzicki, 2020) and the second-largest exporter of fruits and vegetables to Singapore (Ng, 2020). The top regions for fresh produce in China are mostly in the eastern coastal regions, such as Shandong, Hebei, Henan, Jiangsu and Guangdong (Li et al., 2017). Shandong is both the leading agricultural province in China and the top exporter of produce to Singapore; key exports to Singapore include apples, pears and Chinese cabbage (Enterprise Singapore, 2019).

In China, fruits and vegetables are labour-intensive crops that are mainly produced by small-scale farms (on average, among the smallest in the world) (McMillan, 2018). These farms often cooperate in contract farming arrangements or in 'dragon head enterprises' (firms with close ties to regional governments where they are based) for greater economies of scale (Garnett and Wilkes, 2014).

Increasingly, as part of China's heavy investment in its agri-food industry, there have been more greenhouses for vegetable production, (Lan and Zhang, 2018) which are equipped with varying levels of technology [e.g., vertical farming (McMillan, 2018), high-tech farms (Chen, 2018)], but they represent only a small proportion of agricultural production. China's cold chain logistics capacity is also limited, with distribution deficiencies blamed for over US$16 billion of fresh fruit losses in 2014 (U.S. Department of Commerce and International Trade Administration, 2016).

China's agricultural exports were negatively impacted in the short term, mostly due to disruptions of the supply chains. Even then, there was no significant impact on food availability in Singapore, just as it was the case with Malaysia. At the peak of the outbreak, the impact on Singapore was limited to a slight increase in import prices. For example, the price of watermelon—China is the world's largest watermelon producer—increased by 13% year-on-year in February 2020 but adjusted back down in March (Department of Statistics Singapore, 2020b). Similarly, the price of broccoli, a common import from China, increased by 6%, but apples and pears remained relatively stable (Department of Statistics Singapore, 2020b).

The small scale of the problems experienced by Singapore may be due to the small volumes of food it imports. First, experts claim that the adverse impact of the COVID-19 pandemic on the agricultural sector was somewhat mitigated because the worst of the crisis had already passed before harvest time (Wang and Liu, 2020). While there were difficulties with the planting season, this also allowed China to largely avoid the secondary problems of supply gluts witnessed in other countries.

Second, the staged nature of the outbreak supported Singapore's efforts to diversify its sources of imports. China was the first country to experience the COVID-19 pandemic, and through strict measures it managed to start recovering as the rest of the world began its ordeal with the coronavirus. This likely enabled Singapore to rely on other countries during China's strict lockdown, and then on China again during the lockdowns of key trade partners. The Singaporean government has also made commendable efforts to reaffirm trade connexions with China, through conversations between the Chinese minister of commerce and the Singaporean minister for trade and industry (Ministry of Commerce People's Republic of China, 2020) and common participation in international summits like the ASEAN Plus Three Special Summit on COVID-19 (Neo, 2020).

In the Joint Prevention and Control Mechanism, established to combat COVID-19 on 21 January 2020 (Fei and Ni, 2020),

each level of the Chinese government from the central authority to city mayors is made responsible for maintaining food supply chains (Fei and Ni, 2020). A big-data information system, the National Agricultural and Rural Response to Coronavirus Epidemic Data Service Platform, was implemented to enable authorities to monitor food supply and demand and respond quickly to any problems (Fei and Ni, 2020). Differentiated risk assessment and zoning measures were implemented to allow regions at lower risk to resume production, with extra technical services and financial support for farmers. Farmers were advised on how to stagger their production to extend the supply period considering potential disruptions down the supply chain, and the state prepared US$200 million in agricultural production disaster relief funds to support staple crop producers (Fei and Ni, 2020).

The government coordinated efforts to support the specific points in supply chains where there have been the largest disruptions. For example, the Municipal Agricultural and Rural Bureau in Beijing connected local vegetable farming regions to fertiliser companies, and the government of Yangling in Shanxi Province organised online orders and arranged for point-to-point delivery to farmers' homes (Fei and Ni, 2020). Any initial difficulties with distribution networks were also addressed with new governmental regulations to ensure timely transportation of time-sensitive, perishable agricultural products and inputs (Fei and Ni, 2020). Agri-food products were exported under expedited clearance.

In early March 2020, local news reported that the agricultural supply chain was effectively operational, with many companies resuming operations and distribution networks running smoothly (Deutman, 2020). Thus, direct disruptions of the extended food supply chain from China to Singapore because of the COVID-19 pandemic were limited to the short term, with little impact on the island nation's food security.

For the near future, there are other risks to food security that the COVID-19 pandemic has exacerbated. The origin of the coronavirus and China's management of foreign affairs have sparked political tensions around the world, motivating efforts by some countries towards de-sinicization (Johnson, 2020; Myers, 2020). Most prominently, the escalation of tensions between the US and China threatens global food security because of how deeply interconnected the two superpowers are. As a country deeply dependent on international trade, Singapore needs to consider these tensions and how they may impact global food supply chains.

## CONCLUSIONS

The COVID-19 pandemic has quickly and unexpectedly brought about unprecedented and far-reaching disruptions of international food supply chains, from production to logistics and distribution, to retail and to individuals. The impacts of these disruptions have varied drastically, depending on each country, policies and governance as well as the nature of specific commodities and their respective supply chains.

Singapore's food security was affected. Initially, the population's concerns arose from an acute awareness of Singapore's dependence on other countries for food and concomitant vulnerability to international disruptions. This contributed to initial panic buying that created chaos on the retail front and temporarily left shelves empty. Although these problems have been resolved, the physical accessibility of food remains vulnerable to the volatility of public purchasing patterns. Economic accessibility has also been threatened; the prices of some commodities have risen with supply chain disruptions in other countries and fluctuations in international trade connectivity. Falling incomes also exacerbated food insecurity for vulnerable populations. For example, food prices are reported to have increased by 1.6% year-on-year in February of 2021, and sales of the retail sector declined by 6.1% year-on-year in January of 2021, including in terms of food, but not supermarket sales.

The situation in Singapore has improved much compared to February 2020 when the city state was first impacted by the pandemic. As most of the developed countries, the city state responded with financial and social protection measures to protect the economic and social sectors.

One key factor in Singapore's success thus far has been long-term planning, preparedness, and good governance. The government has consistently planned and prepared for possible crises to ensure the resilience of Singapore's food supply chain and food security. One of the important lessons learnt has been that preparedness and responses to public health and food crises require comprehensive, multi-sectoral engagement and planning, as well as strong multilateral cooperation, aspects in which Singapore's efforts have rendered positive results (Caballero-Anthony et al., 2020).

Singapore has managed to protect its food security and food supply chain through a combination of short- and long-term strategies. However, the country should remain cautious. Some aspects of food security have been protected by temporary efforts by the government and the community at large. Nevertheless, given the changing global conditions in food production and prices, and its dependence on outside sources of food, the city state must continue applying proactive strategies to address long-term challenges.

## AUTHOR CONTRIBUTIONS

CT: conceptualisation, investigation, methodology, and writing—review and editing. NL: investigation, writing—original draft, and writing—review and editing. All authors contributed to the article and approved the submitted version.

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## FURTHER READING


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