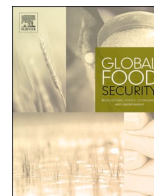




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Food system resilience and COVID-19 – Lessons from the Asian experience

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ABSTRACT

The impact of the COVID-19 pandemic on the food system has exposed the vulnerabilities of the supply chain, although the extent of disruption varies widely, globally and in Asia. However, food systems in Asia have been proven relatively resilient when compared with other regions. This paper considers the immediate effects of the COVID-19 pandemic on the food system, particularly in Asia, and initial responses of governments and global agencies to manage the crisis. A major focus of the paper is on the outlook for food system resilience in a post-COVID-19 environment and likely long-term effects of the pandemic. There is always a possibility of such shock events occurring in the future, hence it seems prudent to look at lessons that may be learned from the responses to the current pandemic.

1. Introduction

Global food and nutrition security have been under threat since well before the arrival of the COVID-19 pandemic. Close to 700 million people go to sleep hungry each night, and of equal significance, more than two billion of world's population suffer from hidden hunger due to a lack of essential micronutrients, such as vitamin A, iron and zinc in diets (FAO, IFAD, UNICEF, WFP and WHO, 2020). Furthermore, according to recent reports from the World Health Organization (WHO) and United Nations Children's Fund (UNICEF), more than 144 million children are stunted, causing developmental problems and susceptibility to lifelong ill health. Estimates for Asia and the Pacific paint a dismal picture: more than 3 million people will need to be taken out of hunger every month to achieve "zero hunger" by 2030, whereas amongst children aged under five, an estimated 77.2 million were stunted in 2018 and 32.5 million suffered from wasting (FAO, UNICEF, WFP and WHO, 2019). At the other end of the scale, more than two billion people are overweight or obese due to excess calorie consumption, increasing their risk of diet-related diseases such as type 2 diabetes, cardiovascular illnesses and various types of cancers. The rates of obesity-related diseases have also soared in many countries in Asia. In total, these various forms of malnutrition present serious health and economic challenges and productivity losses that contribute to global decline in GDP of 5–10%

(Global Panel on Agriculture and Food Systems for Nutrition, 2016).

The impact of COVID-19 on the food and agriculture sector has exposed vulnerabilities of the agri-food supply chain, although the extent of disruption varies widely, globally and in Asia (Garnett et al., 2020). Differences are also likely to be apparent in the ability of supply chains to deliver safe, affordable food of acceptable nutritional quality, and in their resilience and ability to adapt to a new normal, as defined subsequently. Globally, the short-term impacts of COVID-19 have required immediate responses to limit the spread of infection through implementation of health care and containment measures. Controls on people movement, lockdowns, transport restrictions and workplace changes varied considerably. The economic and social impacts, and the possibility of ongoing infections, will play out over the longer term, with concomitant effects on the food and agriculture industry.

The agri-food supply chain connects producers to consumers. It incorporates on-farm activities, postharvest processing and manufacturing, trade and distribution, retail, the food service sector, and regulatory processes for quality and safety assurance. The agri-food system may be considered as an instrument of public health that can deliver health-promoting foods with consumer acceptability. This system faces existential threats from: declining availability of water and soil nutrients; loss of productive arable land due to degradation and urbanization; plant and animal biosecurity; unpredictable weather and

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changing climate, declining public trust and social license.

This paper discusses food system resilience, focusing on countries in the Association of Southeast Asian Nations (ASEAN) as examples of the diverse economies in Asia. The immediate effects of the COVID-19 pandemic on the food system in ASEAN countries and China are then considered, along with the initial responses of governments and global agencies to manage the crisis. A major emphasis of the paper is the outlook for food system resilience in a post-COVID-19 environment.

Many have referred to the COVID-19 pandemic as a black swan event, a term used to describe an unpredicted, rare and catastrophic occurrence. However, the author who coined the term, Nassim Nicholas Taleb, did not use this description (Avishai, 2020) because the likelihood of a pandemic occurring was predicted for some time (Webster, 2018). Nevertheless, the scale of its devastating impact reverberated across the world and will remain for an extended period affecting all aspects of life, in health, social, trade and economics for the world's population. The severe disruption of supply chains has posed a grave risk not seen for over a century during peace times. With the possibility of such occurrences in the future, it seems prudent to look at lessons that may be learned from responses to previous pandemics (Barrett, 2020), and now the current one, especially as many countries in the region have so far appeared to do relatively well in mitigating the initial impacts on communities.

2. ASEAN food supply

2.1. Background to ASEAN

ASEAN is a diverse group of 10 countries, which may be divided economically into three groups according to GDP per capita (\$US): Group 1 with GDP/capita of 53,000 to 10,000 (Singapore, Malaysia, Brunei); Group 2 with GDP/capita of 6000 to 3000 (Thailand, Indonesia, Philippines); and Group 3 with GDP/capita of 2500 to 1000 (Cambodia, Laos, Myanmar, Vietnam). These groupings reflect the ability to sustain externally-originated food supply chains for food imports. In general, the sustainability of supply chains and resilience in food systems is dependent on many factors - arable land for self-production, GDP/capita, capacity for trade, natural resources, infrastructure, investments. There are an estimated 350 million middle class people in the ASEAN region (Bain and Co., 2019) who live mainly in urban centers and are driving demand for diverse food items originating from outside the region and for more animal protein. The trend of increasing urbanization is also reflected in the urban populations, which in 2018 ranged from 23% for Cambodia to 100% for Singapore. ASEAN has varied natural resource foundations to maintain resilient food systems, especially with respect to land. In the ten ASEAN member states, agricultural land as a percentage of total land ranges from 0.9% (Singapore) to 43% (Thailand) (Asian Development Bank, 2020). Arable land accounts for about 16% of total land area in Southeast Asia, but when considered with the 660 million population in 2019, arable land per capita in the region is only about 0.12 ha, among the lowest in the world.

2.2. Food system resilience

As defined by the International Food Policy Research Institute (IFPRI), food systems are "the sum of actors and interactions along the food value chain—from input supply and production of crops, livestock, fish, and other agricultural commodities to transportation, processing, retailing, wholesaling, and preparation of foods to consumption and disposal" (www.ifpri.com). The enabling policy environment and impacts on nutrition, health, environment and sustainability are essential considerations (Fan and Swinnen, 2020). Resilience of food systems is considered in terms of their capacity for eradicating weaknesses and dealing with future uncertainty, including disruptive shocks, taking a holistic perspective over the complexity of such systems (Tendall et al., 2015).

An important aspect to consider when discussing food system resilience is that ASEAN countries are undergoing rapid structural transformation in their agricultural sectors. Asian Development Bank data show that the contribution of agriculture to national GDP has been declining since the 1990s, and now ranges from minimal (Singapore) to a maximum of 23.5% for Cambodia (Asian Development Bank, 2020). At the same time, employment in the agriculture sector has also declined, ranging from less than 1% in Singapore to 33% in Cambodia (World Bank, 2019 data). Both increasing urbanization and declining contribution of agriculture to GDP have implications for food system resilience and the increased importance of supply chains.

Despite its limitations, ASEAN is the source of many agri-food products for the world. Two of the top three rice exporters (Thailand, Vietnam) are in ASEAN. Other commodities in which ASEAN countries rank in the top three exporters in the world are: vegetable oil (Indonesia, Malaysia), coconuts (Philippines, Indonesia), sugar (Thailand), pineapple (Thailand, Philippines), coffee (Vietnam), pulse grains (Myanmar) and cassava (Indonesia). The supply chains for these and other commodities are operated increasingly by large international trading companies. Nevertheless, ASEAN food security is mostly sustained by the inter-locking of a multitude of fragmented supply chains, which originate from within and outside the region and involve many small and medium private enterprises (SMEs). These supply chains support trade and imports that help meet the food security needs of many ASEAN countries and are of considerable economic importance more generally. While trade liberalization has led to a greater integration of supply chains in Asia, they are still much less efficient than those in North America and Europe.

For net food importing countries in ASEAN, notably Singapore, Brunei, Philippines, Vietnam, Cambodia and Laos, supply chains are needed to sustain food security and to provide some degree of resilience. Data from the Economist Intelligence Unit's Global Food Security Index (EIU GFSI) show that a country's food security is not affected by its dependency on imports under normal circumstances (EIU/GFSI, 2019). Furthermore, supply chains that support export trade reflect food systems with surplus production. In ASEAN, agricultural production is still strongly influenced by the importance of rice, the main staple. In this respect, while ASEAN has two of the top three rice exporters, it also has the top two rice importing countries in the world. Three fourths of ASEAN's agri-food products are supplied to countries outside the region, with only about 25% of agri-food trade between ASEAN countries.

2.3. Food security in ASEAN

Food security is the *raison d'être* for sustaining food supply and food system resilience. Hence, it is relevant to consider the most recent EIU GFSI's ranking of ASEAN countries, which are, in decreasing order: Singapore (1), Malaysia (28), Thailand (52), Vietnam (54), Indonesia (62), Philippines (64), Myanmar (77), Cambodia (90) and Laos (92), out of 113 countries. Singapore was ranked highly because of its strong performance under the rubrics of availability, affordability, and quality and safety; this ranking is despite a poor performance for natural resources and resilience, and despite importing about 90% of its food. One explanation is that Singapore has the highest GDP/capita in ASEAN and indeed, in Asia. The EIU GFSI data show a strong correlation between a country's food security and its GDP/capita. But, all this applies only when circumstances are "normal" and there are no disruptions to imports and supply chains.

At the national level, food security and food systems are disrupted by many causes. A framework for considering these disruptions is represented in the scheme in Fig. 1, as published in the report of the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome (HPLE, 2020). This scheme shows how the food system may be influenced by multiple physical, environmental, technological, economic, political, cultural and demographic drivers acting on food production systems, supply chains, consumer behaviour,

SUSTAINABLE FOOD SYSTEM FRAMEWORK

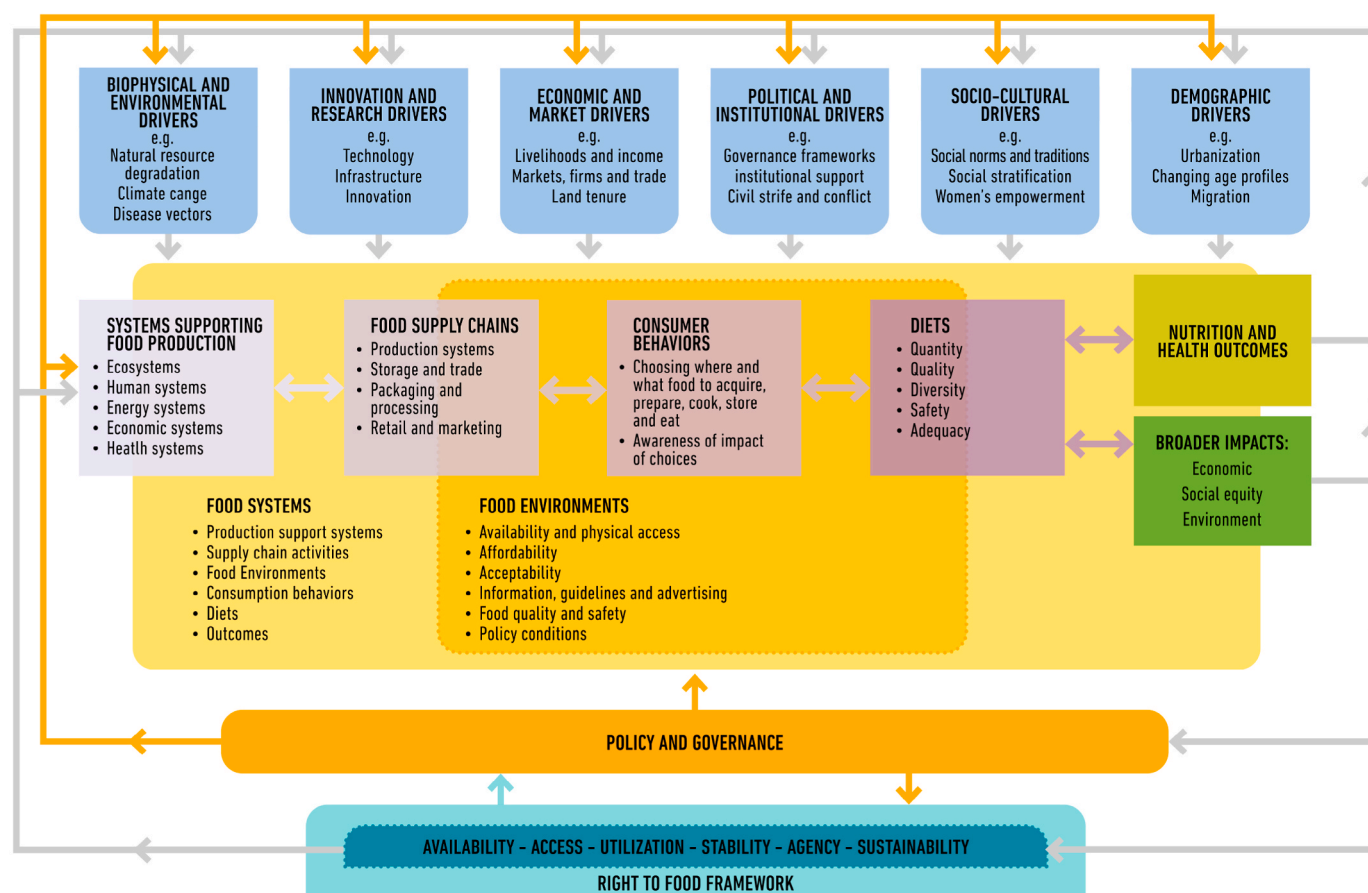


Fig. 1. A framework for considering food security and influencing factors (from HPLE 2020).

diet and nutrition and health outcomes. For example, food availability may be influenced by severe weather events, natural calamities, pest and disease outbreaks, input shortages, pandemics and by trade.

The EIU GFSI also affirms that most ASEAN countries are not sufficiently resilient to face disruptions in their natural resource base or those due to climate change (EIU/GFSI 2019). The GFSI uses the rubric “Natural resources and resilience” to consider resilience in the context of the natural environment; this rubric integrates 21 metrics such as those measuring exposure to climate change factors, water, land and ocean vulnerability, sensitivity and adaptive capacity to risks of food supply disruptions and demographic stresses. ASEAN countries generally drop in their GFSI ranking when this rubric is taken into account. For example, Singapore’s overall GFSI ranking falls to 28 if its score for natural resources and resilience (103 out of 113) is taken into consideration.

2.4. ASEAN vision 2025

COVID-19 is clearly a “wake-up” call for ASEAN as it examines progress towards achieving the ASEAN Vision 2025. The issues around this vision that relate to agriculture food supply and food system resilience are addressed in the ASEAN VISION 2025 (ASEAN, 2015) and its three pillars - the ASEAN Economic Community (AEC), 2015 the ASEAN Socio-cultural Community (ASCC) and the ASEAN Political Security Community. Of these, the AEC and ASCC pillars are particularly relevant to food security, having broad objectives to:

- enhance quantity and quality of production with sustainable, ‘green’ technologies, resource management systems, and minimization of pre- and post-harvest losses and waste;
- enhance trade facilitation, economic integration and market access;
- ensure food security, food safety, better nutrition and equitable distribution;
- increase resilience to climate change, natural disasters and other shocks;
- assist resource constrained small producers and SMEs to improve productivity, technology and product quality, to meet global market standards and increase competitiveness;
- strengthen ASEAN joint approaches on international and regional issues affecting the Food, Agriculture and Forestry sector;
- promote sustainable forest management.

Preliminary assessments of the performance towards meeting the ASEAN objectives show that areas of the plan dealing with the key issues of sustainable production and resilience to climate change have underperformed (ASEAN Secretariat, 2020). Significant gaps were identified in progress towards: promoting sustainable food production; encouraging greater investment in food and agro-based industry; identifying and addressing emerging issues related to food security; supporting evidence-based development of food security and nutrition-enhancing agriculture policies and governance mechanisms. Of particular relevance to the current situation is a lack of preparedness to address emerging issues, such as the COVID-19 pandemic.

3. Global and regional impact of and responses to COVID-19

As the spread of COVID-19 continues to rampage globally, supply chains have been severely disrupted, which poses a worrisome add-on threat to vulnerable countries around the world that will potentially experience a dramatic increase in poverty and hunger. IFPRI estimates that a 1% reduction in economic growth will result in more than 14 million people falling into poverty (US\$ 1.9/day poverty line measured in 2011 PP P). The International Monetary Fund (IMF) forecasted a reduction of 6% economic growth in 2020, which means there will be a total of 80–90 million more poor people globally. The ongoing COVID-19 crisis could add another 130 million to the acute food insecurity population, almost doubling the 2019 number.

The impact of COVID-19 is unprecedented as it differs widely from the global food price spikes in the 2007–2008 period. The impacts are heterogeneous, as the poor suffer more. Impacts are also more intrusive in labor-intensive (vs capital-intensive) systems which are characteristic of poor countries. As the COVID-19 crisis unfolds, trade is affected by closures of ports and export bans disrupting the global food supply chain. Together with slower economic growth and lack of purchasing power, this leads to a cascading impact on the producers and traders and more severely, to the smallholders, youth, women and refugees who have less capacity to cope and recover from the crisis. Countries with public social-safety net programs such as school feeding programs and food banks will face disrupted implementation. A tremendous increase in demand can be expected for assistance from the food banks, which play an important short-term role in distributing food to the urban poor.

Governments and global agencies have provided guidance and taken measures to control people movements to protect the health of the populations. The consequences and severity of the impact as a result from the disruption weighs heavily on the economy, productivity and livelihood of people. In Asia, selected countries are showing signs of recovery in sectors such as logistics and manufacturing; these sectors are making better progress than the food service sector, which is experiencing slower recovery especially in areas affected by imposed restrictions.

In China, food security has been a top priority in Government's response to COVID-19. There has been cooperation between government and various stakeholders from private and public sectors to combat the pandemic and safeguard food and nutrition security for its population. In late January 2020, the Ministry of Agriculture and Rural Affairs (MARA), Ministry of Transport, and Ministry of Public Security jointly

issued a notice urging related departments to coordinate to ensure effective logistics for agricultural products and materials. A week later the State Council called on government ministries for better coordination and emphasized the responsibility of local governors. China opened a “green channel” for fresh agricultural products and prohibited unauthorized roadblocks. It also utilized e-delivery platforms to resolve logistical challenges from smallholders to urban communities, while minimizing the potential risk of infection from visiting crowded food markets. The poultry industry was severely affected by the pandemic due to labor and feed shortages and reduced consumer demand. To overcome these challenges, the National Development and Reform Commission and MARA jointly issued a formal notice to promote expansion of production that guaranteed supply of poultry and aquatic products. The government introduced financial support for food production to prevent a decrease in the credit balances of agriculture-related enterprises and to reduce their financing costs. This support mitigated the burden on farming enterprises by reducing rent or deferring tax payments and social insurance premiums.

A recent report by Oxford Economics for Food Industry Asia (Oxford Economics, 2020) has highlighted early policy responses of ten selected countries in Asia: China, India, Japan, Republic of Korea, Singapore, Indonesia, Thailand, Malaysia, the Philippines and Vietnam. Macroeconomic policies were implemented in all of the countries, along with more specific but widespread measures targeted to the food sector (Fig. 2). For example, all countries shown in the table provided government loans or loan guarantees and tax breaks/subsidies for enterprises including those in food and agriculture. All countries except India, Republic of Korea and Indonesia also provided employment subsidies. In the food sectors, all countries with an exception of Republic of Korea exempted food system workers from lockdowns or provided special green channels for them. Countries in the region refrained from using export bans. By and large, food imports and exports continued to work smoothly, which helped sustain resilience in the food system.

IFPRI has monitored the policy responses in developing countries during this period and found that in some countries in Africa and South Asia major restrictions were placed on urban food traders, who played critical roles in linking producers to consumers. Support was targeted to maintain consumer livelihoods, and there was widespread encouragement for contactless payments. While many social protection systems were launched or resumed, it is notable that the agriculture sector, particularly smallholder farmers worthy of support, received less economic assistance than other sectors. Ministries of agriculture seem to

	Macroeconomic Policy			Food Sector Measures		
	Gov't loans or loan guarantees	Tax breaks/subsidies	Employment subsidies	Lockdown exemption for FS workers	Enhanced govt monitoring & guidance	Increased barriers to food exports
CHN	✓	✓	✓	✓	✓	
IND	✓	✓		✓	✓	
JPN	✓	✓	✓	✓	✓	
KOR	✓	✓				
SGP	✓	✓	✓	✓	✓	
IDN	✓	✓		✓	✓	
THA	✓	✓	✓	✓		Yes
MAL	✓	✓	✓	✓	✓	
PHL	✓	✓	✓	✓	✓	
VNM	✓	✓	✓	✓		Yes

Fig. 2. Policy responses affecting the food industry, June 2020 (Source: Oxford Economics, 2020).

have been excluded from many COVID-19 national response and strategic units.

Global institutions have been stepping up efforts to ensure the smooth functioning of food supply chains amidst COVID-19 challenges. The G-20 ministers of agriculture issued a declaration urging countries not to use export bans. United Nations (UN) agencies called on countries to work together to prevent a global food crisis, and the African Union met in early May to better coordinate and collaborate within Africa and with other regions to prevent a health and food crisis. International organizations including the World Bank, Consortium of International Agricultural Research Centers (CGIAR) and non-governmental organizations (NGOs) like Food and Land Use Coalition (FOLU) all committed to working together to prevent a potential food crisis. Nevertheless, more needs to be done, including the provision of financial support especially to vulnerable populations to cope and recover from economic shocks.

3.1. Post-COVID-19 outlook for food and agriculture

Nutrition and sustainability have long been recognized and incorporated into the key agenda of the Sustainable Development Goals (SDG) launched in 2015. As COVID-19 continues to disrupt the global supply chains, the imperatives of inclusion and importance of resilience have become more critical in our future food supply chain.

Inclusion has a profound and positive influence on the future direction of our supply chain. By better integrating marginalized people (e.g., smallholders, women, youth, refugees and conflict-affected people) into the national food system, inclusive economic growth can be promoted. Poverty will be reduced by increasing household incomes and improving access to services, breaking the cycle of hunger and malnutrition, which can persist across generations. Achieving inclusion will also reduce global and national inequalities and, more importantly, accelerate the post-COVID-19 economic recovery.

In the COVID-19 pandemic, existing constraints faced by smallholders are exacerbated due to a lack of access to credit and training, while food supply chain disruptions hinder access to markets and finance. These impacts tend to be severe for high-value, perishable products often produced by smallholder farmers. Hence, there is a need to ensure the availability of agricultural inputs to farmers, strengthen land tenure security, promote inclusive agribusiness models and facilitate better risk management for these smallholders through social protection, insurance or income diversification to help support business continuity.

Resilience is more than a buzzword. Individuals, communities and national governments need the capability and capacity to deal with and recover from shocks like COVID-19. A resilient food supply chain can help to address conflicts such as those in the Middle East and African countries. Investment in agricultural research and development is key to delivering wins in nutrition and ability to withstand systemic shocks, including from climate. Social protection can secure basic livelihoods, guard against risk and vulnerability, and stimulate growth to set a path to recovery from COVID-19. Given that trade restrictions lead to tighter markets and can exacerbate the ongoing crisis, open, transparent and fair trade must be maintained to build resilience where the poor and hungry people can benefit. Empowering women is also critical to ensure global food security and nutrition as they play an instrumental role in addressing shocks caused by COVID-19 and in linking smallholder farmers to consumers and agricultural production to health and nutrition.

The food system in Asia is not broken currently, but it is stretched and in imbalance, with gaps highlighted and exacerbated by the recent pandemic. On-farm activities have been generally less affected than transport of goods and materials and trade, which were disrupted by the abruptness of labor shortages, restrictions on workers and blockages of transportation. These constraints hamper getting food to the right places in the right form. The most severely affected downstream industries are

air transport and hospitality, with business collapses and closures of operations in associated businesses - hotels, retailers, malls and food services. There are however some pockets of gains amongst food retailers and food markets, who have broadened their outreach through on-line engagement, with customers turning to electronic purchases of foods and essential goods and utilizing delivery services.

In the medium term, producers will need to factor the risks due to imbalances in supply and uncertainty of demand into their business decisions of what to farm or rear. Global industry, including F&A, is built on a just in time cost-efficiency platform. Sudden, low probability but high impact events, such as COVID-19, are not catered for. Stocking, redundancy and disruption of provisioning increase cost and drive down margin. There is a dilemma that if the system is built for resiliency, who will be willing to pay for the tilt in the cost equation? COVID-19 has exposed what has long been taken for granted, namely the smooth flow of goods and services in the just-in-time supply chain.

There is likely to be a synchronized global recession and, with uncertainty about who will provide leadership to help pull the world out, the risk is multiplied. Major changes are anticipated post COVID-19, but there is great uncertainty about what the recovery will look like, with widely differing scenarios suggested ranging from a rapid bounce-back to a long, slow recovery. Recovery from deep recessions normally takes up to two years. The possibility of subsequent waves of the virus is not discounted, depending on the development of vaccines and effective medications. Support programs of governments will play their roles in shaping the recovery. Data in the first quarter 2020 from various countries have suggested full year GDP reduction of between -2% and -8%. The world is now facing higher debt at country level and by individuals, coupled with high job losses and lower incomes across all sectors. The Economist publication recently stated that the world may face an economy after COVID-19 that could be about 10% smaller (The Economist, 2020).

Numerous factors will shape the F&A industry post-COVID-19. Despite uncertainty about how the post-COVID-19 environment will look, in Asia and globally, some reasonable predictions might be made, as represented schematically in Fig. 3. This scheme shows the various influencing factors Predicted to act on the real economy, human behavior, industry and supply chain and geopolitics. Leaders in the F&A sector are now reviewing their whole supply chain, with significant changes in consumer and social behavior likely to drive many of the trends. Working from home, coupled with less commuting and business travel, will become more acceptable, and cautiousness and anxiety will impact on purchases and activities, especially in the hospitality and food service sector. Nations are showing a tendency towards nationalism, driven by domestic sentiments and outlook, adding to global trade tensions and challenging the globalization structure.

Post COVID-19, modernization of the F&A system will be accelerated in Asia, driving better efficiency and a shift away from an intensely labor dependent model. Improvements in technology will lead to rethinking of local supply chains. Innovation will play an important role as, for example, SARS in 2003 helped to accelerate e-commerce in China, with emergence of big tech companies such as Alibaba's Taobao connecting consumers directly to suppliers.

Increased working from home will, in turn, drive further consumer changes. Consumers are likely to cut back their expenditure on discretionary items due to the recession. E-commerce will be accelerated, with reduction of intermediate agents, as widely seen in many parts of Asia. There will be greater adoption of digital technology across the whole agri-food supply chain, from production to consumption, and for better connection of farmers to their input supplies and customers. The disruption and change brought about by the pandemic will likely see consolidation of many small farmers and small businesses. The big F&A companies are expected to increase their market share and enlarge their eco-system. A more resilient integrated supply chain will emerge, in which operations will be increasingly driven by digitization, automation, robotization, AI, block-chain, and big data to enhance supply

Factors shaping F&A industry post-Covid-19

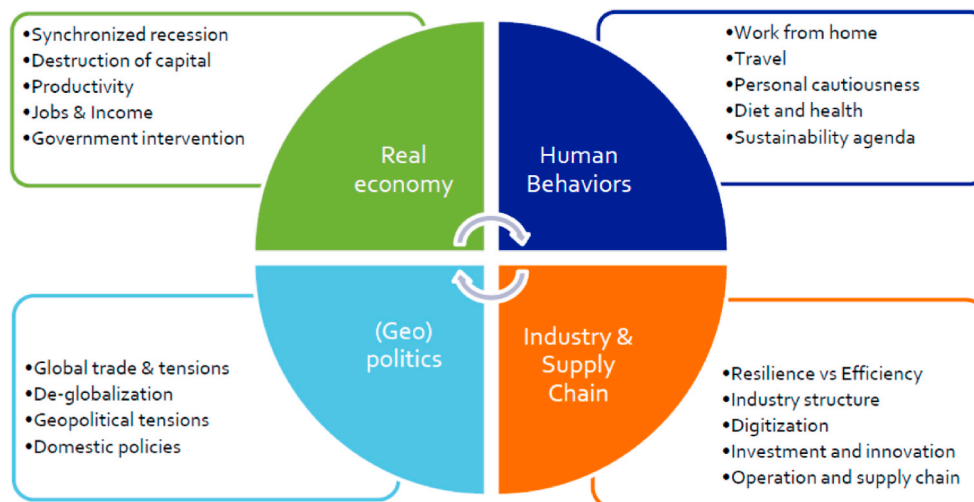


Fig. 3. Factors shaping F&A industry post-COVID-19 (Source: Rabobank).

security, efficiencies production, and transparency. Supply chain and inventory management are already under review to build resiliency. China and South East Asia are net importers of food commodities and meats and there will likely be more consideration for storage and national self-sufficiency and stockpiling and sourcing policies. There are many opportunities to reduce waste along the long, fragmented supply chain.

Some of these predicted developments are already happening due to Asia's longer-term food supply issues. However, from a recent joint report on *The Asia Food Challenge* (www.asiafoodchallenge.com) published by Rabobank, Temasek Holding Singapore and PwC, it is clear that Asia falls short in producing its food supply needs with current practices and technology. Consumer demand for food, which is more nutritious and safer, will increase from urbanization, and population and income growth. Another key issue is how to feed Asia's numerous and huge cities. And, all of these challenges will be coupled with changing environment and climate (Reardon and Zilberman, 2018). The pandemic clearly highlights that when population is concentrated, the supply chain to mega-urban centers is challenged.

4. In the future

Agriculture is a biological system exposed to nature, with many confounding factors affecting decision-making. The supply chain presents challenges beyond production, including food loss and waste, food safety, both under and overnutrition, supply/demand balance and inequality of access. Decisions are often based on managing risks, in production, the market, trade and government policies; establishing the value proposition in a decision comes from analysing the specific risks (not just the hazards) and the risk appetite.

The COVID-19 pandemic has been a wake-up call for thinking on supply chains and resilience of the future food system. Many known issues in food sustainability and nutrition have been brought back into sharper focus, along with the need to consider longer-term transformations resulting from a slow economic recovery, changes in consumer behavior and managing risk of future disruption. The global slowing down of economies may make nutritious and healthy foods less affordable for low income families, necessitating social measures or safety nets to protect them. Consumer demand for some high-value

agricultural products may also be reduced.

COVID-19 has highlighted the need to support smallholders, who are still a major part of the food system in Asia. Most of the more than 400 million farmers in Asia are small holders, while 90% of food processors and manufacturers are SMEs. Building a strong base for innovation and investment that addresses their needs will help overcome their constraints and encourage more enterprising technology and sustainability. Improving information flow to farmers, processors, food manufacturers and traders, on weather, resources, markets and prices will enable them to make more effective business decisions by weighing risks and returns based on better understanding. Inclusion is another key pillar for shaping and future-proofing our supply chain against crisis shocks and addressing food and nutrition insecurity. Protecting the more vulnerable, particularly women, children and the elderly, will help them meet their dietary and nutritional needs.

Advances in technology continue apace, but there is a lag in socio-economic analysis and policy development to facilitate adoption of innovations that will make a difference. Agricultural production is still dependent on labor, but recent concerns about availability of itinerant workers is making businesses look increasingly to automation. Effects on international trade are leading businesses to think about sourcing locally vs overseas, and concomitant needs for storage. It will be important to find suitable rewards to promote good agricultural practices and help consumers choose sustainably produced food. There are also challenges to convince governments across the world that global trade must remain open to help countries ensure the smooth functioning of food supply chains. COVID-19 should not be used as an excuse to set up trade restrictions. [ASEAN Cooperation \(2020\).bib_ASEAN_Cooperation_2020](#)

Data from the [EIU GFSI 2019](#) affirms that a country's food security is improved with more investment in agricultural R&D. In this regard, some priority areas for research investment should include, but not be limited to, new farming systems that are climate smart, finding ways to measure and improve sustainability, new technologies to reduce carbon emissions and improve water use, information systems for application throughout the agri-food chain, improve nutrition including the role of novel sources of protein from plants and insects, the potential for urban farming, and bridge the urban-rural divide to raise the profile of agriculture. Going forward, concerted efforts of stakeholders in both public and private sectors to invest in innovation, infrastructure and education

for the global food system will be even more crucial.

5. Conclusions

The assessment of progress towards the ASEAN VISION 2025 identified significant gaps for agriculture food supply and food system resilience. However, when the system was sharply stress-tested by the COVID-19 crisis, the Asian food system, in general and contrary to expectations, has remained remarkably resilient. There have been no major breakdowns of food supply, trade has not been seriously affected, and there is no evidence of food shortages in markets or increased hunger and malnutrition. Reasons for this may include the region being relatively well served by road infrastructure, access to internet and mobile phones, and well-developed supply chains. The policy interventions outlined in Fig. 2 and a tradition of collective action for societal benefit are also likely to have been significant factors. What actions for the future can help to ensure the food system remains resilient and supply chains are able to withstand future shocks? The COVID-19 experience indicates the importance of keeping green channels open for foods and for rural workers, further strengthening social protection and safety nets, continuing to invest in research and infrastructure, better regulations of wet markets and wildlife, and influencing consumer behavior towards more sustainable and healthier foods.

Declaration of competing interest

The authors declare no conflicts of interest.

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