Chapter 16

Food and Agriculture

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Introduction

This chapter focuses on the food and agriculture sector in the context of value-adding strategy through innovative technologies. It discusses the strategy of enhancing the resilience of the food value chain and agricultural productivity with digital and other advanced technologies. It also addresses the global focus on a sustainable food system.

The contribution of the agriculture sector to the national economies of Southeast and East Asian countries has gradually declined with economic growth. The contribution of agriculture, forestry, and fisheries to gross domestic product (GDP) is not large – even in the least developed countries (LDCs) of the region (Table 16.1; Figure 16.1). However, in terms of jobs, the ratio of agricultural employment to total employment cannot be ignored (Table 16.2; Figure 16.2). This is particularly evident in Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, and Viet Nam (the CLMV countries). Furthermore, the rural population in the Association of Southeast Asian Nations (ASEAN) Member States is still higher than the urban population. Therefore, for ASEAN Member States (AMS), especially CLMV countries, improving the productivity of the agriculture sector has large potential to increase income levels and decrease the disparity between urban and rural areas.

Table 16.1 Agriculture, Forestry, and Fishing Value Added
(% of GDP, 2020)

Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam	China	Japan (2019)	Republic of Korea
1.2	22.4	13.7	16.2	8.2	22.0	10.2	0.0	8.6	14.9	7.7	1.0	1.8

GDP = gross domestic product.

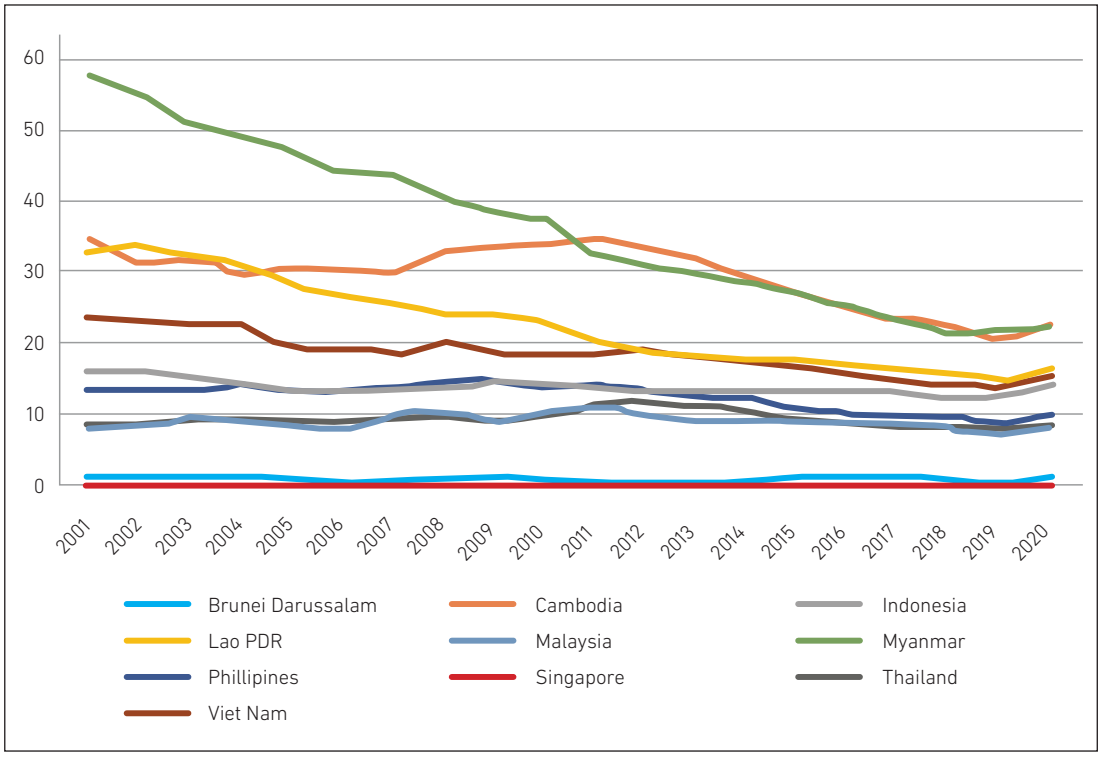
Source: World Bank (n.d.), Agriculture, Forestry, and Fishing, Value Added (% of GDP). https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?name_desc=false (accessed 14 January 2022).

Table 16.2 Employment in Agriculture
(% of total employment, 2019)

Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam	China	Japan (2019)	Republic of Korea
2.0	34.5	28.5	61.4	10.3	48.8	22.9	0.0	31.4	37.2	25.3	3.4	5.1

Source: World Bank (n.d.), Employment in Agriculture (% of total employment) (modelled ILO estimate). https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?name_desc=false (accessed 14 January 2022).

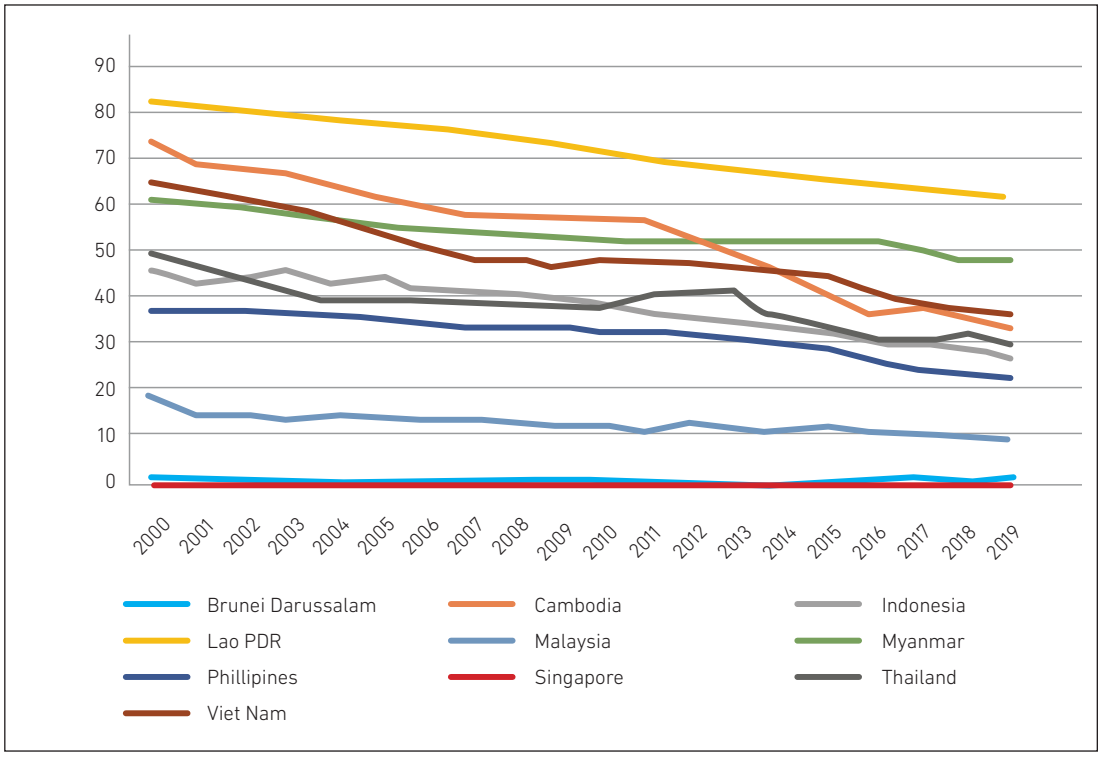
Figure 16.1 Transition of Agriculture, Forestry, and Fishing, Value Added
(% of GDP)



GDP = gross domestic product.

Source: World Bank (n.d.), Agriculture, Forestry, and Fishing, Value Added (% of GDP). https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?name_desc=false (accessed 14 January 2022).

Figure 16.2 Transition of Employment in Agriculture
(% of total employment)



Source: World Bank (n.d.), Employment in Agriculture (% of total employment) (modelled ILO estimate). https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?name_desc=false (accessed 14 January 2022).

The food and agriculture sector is facing various challenges. Steady population growth, which is projected to increase from 7.8 billion in 2020 to more than 9.8 billion in 2050 globally and from 4.6 billion to more than 5.3 billion in Asia during the same period (United Nations Department of Economic and Social Affairs, 2022) – indicates a continuous increase in food demand. To meet this growth, a rapid increase in food supply is a priority issue. However, it is difficult to increase productive agricultural land area rapidly, so acceleration of agricultural productivity with innovation is urgently needed (Table 16.3).

Table16.3 Agricultural Land Area
(1,000 ha)

Item		2010	2019	Average annual growth rate (%)
World	Agricultural land	4,795,848	4,752,111	–0.10
	Arable land	1,361,101	1,383,346	0.18
East Asia	Agricultural land	652,173	650,547	–0.03
	Arable land	130,795	128,571	–0.19
Southeast Asia	Agricultural land	127,497	138,961	0.96
	Arable land	68,117	72,886	0.75

ha = hectare.

Source: FAO (n.d.), FAOSTAT, Land Use. https://www.fao.org/faostat/en/#data/RL (accessed 21 September 2021).

Several emerging issues also have adverse impacts on food security. Natural disasters and damage – such as droughts, floods, and outbreaks of pest and plant disease caused by climate change – increase in frequency and scale every year globally. These disasters directly affect agricultural production. In addition, the coronavirus disease (COVID-19) pandemic has disrupted the food supply chain and affected agricultural production globally and regionally. Tackling these challenges requires enhancement of resilient food and agricultural supply chains with innovative technologies, ranging from production, processing, and distribution to consumption.

To enhance the resilience of food supply chains and ensure food security, various research studies and organisations recommend the application of digital technologies in the food and agriculture sector. Further, the development of a modern cold chain that can maintain food quality, secure food safety, and reduce post-harvest loss and food loss is an effective means to improve the food and agricultural supply chain – especially in Southeast Asia, which is mostly tropical.

Regional Food Security

Although the term 'food security' is used in various contexts, the most accepted definition is: 'Food security exists when all people, at all times, have physical, [social] and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life' (FAO, 2008: 1). This definition was agreed at the 1996 World Food Summit, and the term 'social' was added in 2002. The definition identifies the four main dimensions of food security: (i) the physical **availability** of food, (ii) economic and physical **access** to food, (iii) food **utilisation**, and (iv) the **stability** of the other three dimensions over time (FAO, 2008). When we assess the status of food security in any country and/or region, these dimensions need to be considered.

Status of Regional Food Security

According to two notable food security indicators – the prevalence of undernourishment[1] and the prevalence of moderate or severe food insecurity[2] in the total population – undernourishment has been improved steadily and continuously in these two decades. However, food security has deteriorated in many Southeast and East Asian countries in line with global trends, as a result of COVID-19 (Table 16.4; Figure 16.3).

Table 16.4 Indicators Related to Food Security

Countries/ Regions	Prevalence of undernourishment in the total population (%)			Prevalence of moderate or severe food insecurity in the total population (%)		
	2014–2016	2017–2019	2018–2020	2014–2016	2017–2019	2018–2020
Brunei Darussalam	<2.5	<2.5	<2.5	n.a	n.a	n.a
Cambodia	8.9	6.8	6.2	48.9	44.1	44.8
Indonesia	7.0	6.4	6.5	6.0	7.0	6.2
Lao PDR	6.7	5.4	5.3	n.a	n.a	29.4
Malaysia	3.8	3.2	3.2	17.4	15.1	18.7

[1] **Prevalence of undernourishment:** This indicator is an estimate of the proportion of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life. It is expressed as a percentage (Global SDG Indicator Platform, n.d.). This indicator will measure progress towards the Sustainable Development Goal (SDG) Target 2.1. (By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious, and sufficient food all year round.)

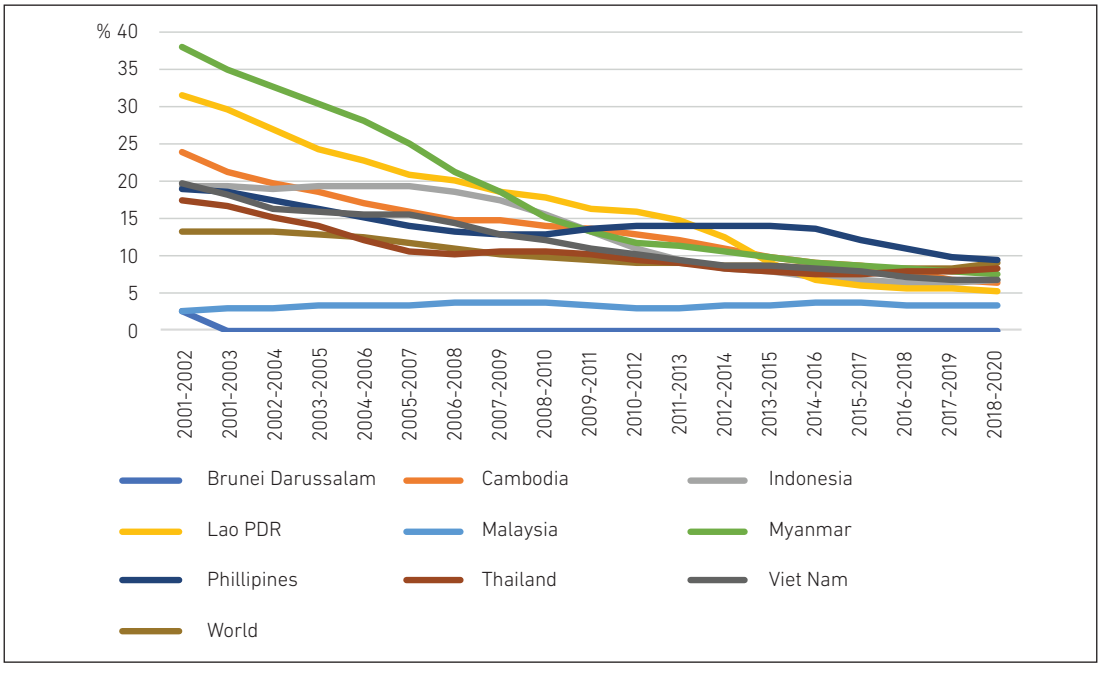
[2] **Prevalence of moderate or severe food insecurity in the total population:** This indicator provides internationally comparable estimates of the proportion of the population facing moderate or severe difficulties in accessing food. The Food Insecurity Experience Scale (FIES) produces a measure of the severity of food insecurity experienced by individuals or households, based on direct interviews. The indicator will measure progress towards SDG Target 2.1 (FAO, 2021a). Data are available from 2014.

Countries/ Regions	Prevalence of undernourishment in the total population (%)			Prevalence of moderate or severe food insecurity in the total population (%)		
	2014–2016	2017–2019	2018–2020	2014–2016	2017–2019	2018–2020
Myanmar	8.9	7.8	7.6	n.a	n.a	22.2
Philippines	13.3	9.7	9.4	41.2	41.2	42.7
Singapore	n.a	n.a	n.a	2.8	4.7	4.5
Thailand	7.3	7.9	8.2	15.1	26.4	29.8
Viet Nam	8.1	6.8	6.7	6.3	6.2	6.5
China	<2.5	<2.5	<2.5	n.a	n.a	n.a
Japan	<2.5	<2.5	<2.5	2.6	3.2	3.4
Republic of Korea	<2.5	<2.5	<2.5	4.8	5.2	5.1
World	8.3	8.3	8.9	23.0	25.8	27.6

n.a. = not applicable.

Source: FAO (n.d.), FAOSTAT, Suite of Food Security Indicators. https://www.fao.org/faostat/en/#data/FS (accessed 21 September 2021).

Figure 16.3 Prevalence of Undernourishment in the Total Population



Source: FAO (n.d.), FAOSTAT, Suite of Food Security Indicators. https://www.fao.org/faostat/en/#data/FS (accessed 21 September 2021).

Regional Initiative for Ensuring Food Security

To address the food security issues, the ASEAN Ministers of Agriculture and Forestry adopted the ASEAN Integrated Food Security (AIFS) Framework and Strategic Plan of Action on Food Security in the ASEAN Region (SPA-FS) 2021–2025 in October 2020, as a successor to the 2015–2020 AIFS Framework and SPA-FS. The AIFS framework is a regional umbrella for initiatives related to food security, and the goal is to ensure long-term food security and improve the livelihoods of farmers in the ASEAN region (Islam and Kieu, 2020). In this framework, two key mechanisms are stressed: (i) the ASEAN Plus Three Emergency Rice Reserve (APTERR) and (ii) the ASEAN Food Security Information System (AFSIS).

The APTERR aims to strengthen food security, alleviate poverty, and eradicate malnourishment amongst its members – including the AMS plus China, Japan, and the Republic of Korea – without distorting normal trade. Under the APTERR, the rice reserve is available for consumption through a three-tier programme. During 2020–2021, the tier three programme, designed for acute emergencies and other humanitarian responses to food insecurity, distributed 5,029 metric tons of rice contributed by Japan and the Republic of Korea to address emergencies including natural calamities and the COVID-19 pandemic in Cambodia, Myanmar, and the Philippines (APTERR, n.d.). Since its establishment as a permanent mechanism in 2013, following its preparatory stage and the East Asia Emergency Rice Reserve pilot project, APTERR has been contributing to regional stability in terms of food security. In contrast, AFSIS started operations in 2003 and has been implementing projects to strengthen food security in the region through the systematic collection, analysis, and dissemination of data and information related to food security. AFSIS also publishes the ASEAN Agricultural Commodity Outlook and Early Warning Information reports.

APTERR and AFSIS have been contributing to ensuring regional food security since their establishment. To help boost the potential of these mechanisms, APTERR could consider expanding the coverage of the target commodity (rice) to other crop commodities that are important for regional food security – such as maize, soybean, sugar, and cassava. AFSIS could be transformed into a permanent mechanism like the APTERR, to provide more stable operations.

Support from Development Organisations

Apart from regional initiatives, support from development partners has played an important role in ensuring national food security in LDCs through various projects. For example, in Cambodia, which is in a relatively high food insecurity situation, different international development organisations – such as the World Bank, Asian Development Bank (ADB), International Fund for Agricultural Development, Agence Française de Développement, Japan International Cooperation Agency, and Korea International Cooperation Agency – are implementing projects in the fields of agriculture, natural resources, and rural development. These include interventions for the development/improvement of the agricultural value chain, inclusive marketing for smallholders, water resources management, and climate-resilient agriculture (ADB, 2021). These projects contribute significantly to enhancing national food security by reducing poverty, improving rural livelihoods, raising farm productivity, and increasing smallholders' income.

Utilisation of Digital Technologies in the Food and Agriculture Sector

Digital transformation has penetrated the food and agriculture sector in recent years. Digital innovations and technologies are expected to be part of the solution for the constraints and challenges facing the global agriculture sector. Digitalisation of the food and agriculture sector has the potential to deliver not only economic benefits through increased agricultural productivity, cost efficiency, and market opportunities, but also social and cultural benefits through increased communication in an inclusive manner as well as environmental benefits through optimised resource utilisation (Trendov, Varas, and Zeng, 2019). Although the potential benefits of digitalising the agriculture sector are convincing, we need to pay attention to challenges that often be observed in the agriculture sector and rural areas, such as the gap in basic conditions for digital transformation including infrastructure and connectivity (e.g. internet access, mobile network coverage, and electricity supply); digital literacy of rural workers; and the institutional support system. Along with issues regarding the digital divide, the gap in data collection ability is a challenge to be addressed.

Developed countries prepare and implement national or regional strategies and/or government initiatives for enhancing the utilisation of digital technology in the food and agriculture sector. For example, European Union (EU) member states signed a declaration on 'A smart and sustainable digital future for European agriculture and rural areas' in 2019, which stresses the potential of digital technologies to help tackle important and urgent economic, social, climate, and environmental challenges facing the EU's agri-food sector and rural areas. In Japan, the Ministry of Agriculture, Forestry and Fisheries is implementing a package of measures to promote digital agriculture or 'smart agriculture' that consists of (i) demonstration, analysis, and dissemination of smart agriculture (e.g. demonstration site of smart agriculture); (ii) creation and dissemination of new support services to farmers; (iii) creation of an enabling environment (e.g. agricultural data collaboration platform); (iv) provision of education on smart agriculture; and (v) overseas promotion (e.g. collaborative projects and technical assistance for developing countries).

Status of Digital Technology Use in ASEAN Agriculture

In AMS, the food and agriculture sector has been active in digital innovation for the past several years, but in a differentiated way. In the past two decades, global advances in precision agriculture, remote sensing, robots, farm management information systems, and computer-aided decision support systems have paved the way for a broad digital transformation in farming in selected countries and some parts of the food value chain. Recent developments – such as the internet of things, big data, blockchain, drones, and artificial intelligence – allow for the integration of isolated lines of development into smart, connected agricultural production systems and resilient food value chains.

The Organisation for Economic Co-operation and Development (OECD, 2019) divided the existing digital technologies in relation to data in food and agriculture into five purposes and 12 categories (Table 16.5).

Table 16.5 Uses of Digital Technologies in the Food and Agriculture Sector

Technology purpose	Category	Sub-category (example)
Data collection technologies	Remote sensing	Satellite-mounted data acquisition/monitoring systems, drone-mounted data acquisition/ monitoring system, etc.
	In situ sensing	Water quality sensors, air quality sensors, in situ meteorological sensors, crop monitors, livestock monitors, data from precision agricultural machinery, etc.
	Crowdsourcing data collection	'Serious games' for gathering agri-environmental data, etc.
	Online surveys/ censuses	Data collection portals (e.g. online census)
	Financial/market data collection	Retail scanner data, business software for recording financial or market information (e.g. database entry systems)
Data analysis technologies	GIS-based and sensor-based analytical tools	Land use–land cover mapping, soil mapping, software (e.g. programs, apps) for translating sensor and other farm data into actionable information, software for automating agricultural machinery which uses sensor or other farm data as input, software for measuring and grading agricultural outputs, etc.
	Crowdsourcing data analysis	Crowdsourcing applications for data sorting/ labelling
	Deep learning/AI	Data cleaning algorithms, big data analysis algorithms, machine learning, predictive analytics
Data storage technologies	Secure and accessible data storage	Cloud storage, confidential computing, virtual data centres
Data management technologies	Data management technologies	Distributed ledger technologies (e.g. blockchain), interoperability programs and apps
Data transfer and sharing; digital communications; trading, payment and service delivery platform	Digital communication technologies	Social media, web-based video conferencing, machine-assisted communication (e.g. chatbots), etc.
	Online platforms - property right, payment, services, and market	Online property rights and permits registries, online trading platforms, online payment platforms, service delivery platforms, etc.

AI = artificial intelligence, GIS = geographic information system.

Source: OECD (2019), modified by author.

These digital technologies have not yet been fully utilised in AMS, and are expected to help the food and agriculture sector in ASEAN to evolve in a data-driven, intelligent, agile, and interconnected system of systems. In the Fourth Industrial Revolution that is reaching ASEAN, the operations of each agricultural process will have the potential to be automatically integrated in the regional food chain.

According to a survey conducted in 2021 by the Economic Research Institute for ASEAN and East Asia (ERIA) through its research network, the baseline situation of digital technology utilisation in the food and agriculture sector in ASEAN is as follows.

Potential for digitalised food and agricultural production:

- Lack of knowledge and skills of users
- Limited internet access for some farmers in rural areas
- High start-up costs for the procurement of digital equipment
- High maintenance and data analysis costs
- Need for exploring the possibility of smart farming in various subsectors (the utilisation of digital technology currently concentrates mostly on crops and some aquaculture application)

Potential for digitalised food supply chain and finance:

- Mostly ad hoc approaches to digital marketing of products
- Limited resources to comply with traceability requirement
- Need for training on maintaining field records
- Need for harmonised standards for traceability
- Need to assure consumers of the origin and quality of the products
- Need to prevent commercial fraud in meeting the needs of domestic and international consumers

Thus, there are many challenges and opportunities in digital transformation in the ASEAN food and agriculture sector.

Until 2021, ASEAN did not have a consolidated regional strategy for the utilisation of digital technologies in the food and agriculture sector that could enhance farm productivity and improve supply chain resilience at the scale required. ASEAN's Vision and Strategic Plan for ASEAN Cooperation in Food, Agriculture and Forestry, 2016–2025 serves as the regional strategic plan for the food and agriculture sector. It clearly states the priority areas of cooperation, strategic thrusts, and action programmes. However, it only mentions information and communication technology (ICT) as a method of extension and dissemination of successful technologies, and does not describe the utilisation of digital technologies in the food and agriculture sector comprehensively. The ASEAN Comprehensive Recovery Framework (ACRF) – the consolidated exit strategy from

COVID-19 agreed in 2020 – prioritises accelerating inclusive digital transformation as one of the five main strategies, but does not focus on the utilisation of digital technologies in the food and agriculture sector. However, the implementation plan of the ACRF mentions the need to develop ASEAN guidelines on the utilisation of digital technologies for the ASEAN food and agriculture sector, to be adopted in 2021. Based on this situation, ASEAN started paying attention to the development of regional guidelines on promoting the utilisation of digital technologies in the food and agriculture sector.

ASEAN Guidelines on Promoting the Utilisation of Digital Technologies for ASEAN Food and Agricultural Sector

In response to the need to formulate regional guidelines on the utilisation of digital technologies in the food and agriculture sector, based on evidence-based information and regional consultation, related ASEAN sectoral working groups (e.g. the ASEAN Technical Working Group on Agricultural Research and Development) discussed the actual and potential status of digital agriculture in ASEAN as well as the contents of the guidelines, with support from the ASEAN Secretariat and relevant institutions including ERIA. Several regional workshops were organised in 2021 for AMS to identify and consider good practices and potential technologies as well as government initiatives, with the participation of resource persons from academia, government, and the private sector in Asia and other regions. As the outcome of a series of discussions, the draft ASEAN Guidelines on Promoting the Utilisation of Digital Technologies for ASEAN Food and Agricultural Sector were prepared, and later endorsed at the 43rd Meeting of the ASEAN Ministers of Agriculture and Forestry on 27 October 2021.

The guidelines aim to provide guidance not only for ASEAN governments but also for various stakeholders in the food and agricultural value chain – including producers and technology users (e.g. farmers, fishers, and other producers); agribusiness enterprises and key players in the agri-tech industry; financial and lending institutions; academic and research institutions; and civil society. An outline of the guidelines is in Figure 16.4.

The ASEAN guidelines are comprehensive and cover various aspects such as the use of technologies, the enabling environment, and capacity development.

Figure 16.4 Outline of the ASEAN Guidelines on Promoting the Utilisation of Digital Technologies for ASEAN Food and Agricultural Sector

1	Background
2	Objective and orientation
3	Scope and definitions
4	Accelerating the transformation of the ASEAN food and agriculture sector through digital technologies and innovations and its challenges
5	ASEAN Guidelines on Promoting the Utilisation of Digital Technologies for ASEAN Food and Agricultural Sector
	Guideline 1: Contribute to food security, food safety, and nutrition by improving the value chains (production, post-production, market access/linkages, and value addition)
	Guideline 2: Support equitable, sustainable, and inclusive economic development in the food and agriculture sector; and ensure much-needed investment in infrastructure and related support services (e.g. digital banking, accounting, and investment for access to loans, microfinance, and reporting)
	Guideline 3: Support the generation and diffusion of appropriate digital innovations for resource-efficient, sustainable, and safe food and agriculture sector
	Guideline 4: Foster capacity building, engagement, and empowerment – especially for the youth, women, and marginalised groups
	Guideline 5: Improve the resilience of the food and agriculture sector during disruptions caused by unprecedented events and shocks
	Guideline 6: Strengthen regional partnerships/approaches for digital innovations in the food and agriculture sector
6	Roles and responsibilities of stakeholders

ASEAN = Association of Southeast Asian Nations.

Source: Author's compilation.

As a next step, each AMS should prepare national strategies on the utilisation of digital technologies in the food and agriculture sector and/or a road map for digitalising agriculture, in line with the domestic agricultural situation and strategy of each country, referring to the agreed regional guidelines. There is no one-size-fits-all solution leading to the digital transformation of the food and agriculture sector, and each country has its own priorities.

Cold Chain Development

A cold chain is an indispensable element to consider in the development of a global as well as a domestic food supply chain, especially for perishable products such as higher value processed, livestock, dairy, and aquatic products. Although the cold chain is defined in various ways in the literature, it can be described as a type of supply chain that involves the storage and transportation of temperature-sensitive goods. Cold chains can be classified into three main fields: (i) food cold chains; (ii) pharmaceutical cold chains; and (iii) other cold chains (e.g. cold chains for semiconductors). This section focuses on the food cold chain, so references to 'cold chain' are to the food cold chain. The cold chain involves uninterrupted transportation and storage activities within a low and controlled temperature range to extend or maintain fresh food products (Ali, Nagalingam, and Gurd, 2018). In other words, a cold chain requires seamless connectivity with controlled temperature from production to consumption. To realise the connectivity, cold storage and refrigerated transport are indispensable infrastructure.

Cold Chain in ASEAN

A cold chain is a significant element in the improvement of food value chains and the realisation of higher value addition of agricultural products, especially in AMS as they mostly have tropical climates. In the ASEAN region, various factors – including increased income caused by economic growth, an increase in the number of middle-income households, lifestyle changes, and the rise of modern supermarkets – have contributed to the rapid expansion of demand for cold chains. Data from a recent study indicated that demand for cold chains has steadily increased in some AMS. For example, frozen food consumption in Indonesia rose from 5,082,000 tons in 2014 to 6,631,000 tons in 2018, an annual average increase of more than 6%. In the Lao PDR, the import of frozen, chilled, and fresh products that require temperature control increased from $3.14 billion in 2015 to $3.84 billion in 2017 (Kusano, 2019). In addition, the COVID-19 pandemic has accelerated the growth of online grocery and e-commerce, which contributed to the growth in demand for cold chains.

However, in most AMS, the cold chain system is underdeveloped or not functioning well due to various causes. A case study conducted in Viet Nam pointed out several obstacles to cold chain implementation, including deficient professional skills, lack of quality and safety control measures, poor infrastructure, high installation and operation costs, inadequate education and training for farmers, deficient standardisation, and lack of government support for local businesses (Gligor, Tan, and Nguyen, 2018). An ADB report

on Cambodia's agriculture and rural development also pointed out that the country does not have a reliable cold chain system to ensure the proper handling and safe storage and distribution of perishable agricultural and food products (ADB, 2021). This status of cold chains is one of the bottlenecks for the development of a resilient food supply chain and the realisation of higher value addition of agricultural products.

Cold Chain Constraints, Challenges, and Solutions in ASEAN

A cold chain study conducted in 2020/2021 by ERIA identified several constraints and challenges for the development of a cold chain in ASEAN. Typical issues are as follows.

Cold chain infrastructure and tools related issues

(i) **High investment costs to enter cold chain business:** The initial investment cost for a cold chain business is relatively high because cold storage needs to be constructed as an essential facility and requires refrigerated trucks. Most farmers and agribusiness operators are categorised as micro, small, and medium-sized businesses. It is very difficult for such businesses to prepare essential facilities and equipment for cold chain businesses by themselves.

(ii) **Lack of appropriate equipment for temperature measurement and records in storage and transportation across the supply chain:** Consistent temperature control along the cold chain and traceability require the installation of equipment for continuous temperature measurement and recording. However, many cold chains do not have such equipment installed.

(iii) **Lack of stable and affordable power supply:** A modern cold chain needs stable electricity supply to keep products within the range of designated temperatures. Perishable food products lose their value if the temperature in the cold storage rises, even during a short power outage.

Institution, strategy, standards, and regulation

(i) **Lack of specialised government institution or organisation focusing on cold chain development:** A cold chain is a form of food value chain that involves a wide range of activities, including the production of raw materials, processing, distribution, and consumption. Thus, the development of cold chains is a kind of cross-cutting challenge, as it involves various stakeholders and activities. Typically, several ministries – such as the Ministry of Agriculture, the Ministry of Transportation, the Ministry of Trade, and other ministries and agencies – are engaged in cold chain development. Therefore, communication and coordination amongst ministries and agencies are very important for cold chain development. However, ministries and agencies often work individually, with poor coordination or lack thereof, creating institutional constraints.

(ii) **Lack of clear strategies for cold chain development across the chain:** Integrated national strategies for cold chain development are rarely in place, perhaps because of the diversity of ministries and agencies involved in this area. A cold chain development strategy should be formulated in line with higher-level policies such as national development plans and food security policies.

(iii) **Lack of standards and regulations by product:** As cold chain handling differs by product (e.g. fruit and vegetables, livestock products, and marine products), detailed product-specific handling standards are required. At present, few countries have such standards or guidance.

Human resources

(i) **Lack of skilled personnel in cold chain operations:** When temperature control in cold storage and refrigerated trucks is not managed properly, the quality of food products deteriorates and can affect consumers' health. Operators engaged in cold chain operations often have insufficient knowledge and skills in terms of cold chain handling.

(ii) **Lack of awareness and knowledge of cold chain impacts on product quality and value:** Operators who are directly involved in cold chain operations – such as farmers, cold storage managers, refrigerated truck drivers, and retailers – frequently do not have sufficient knowledge of cold chain impacts on food quality and safety. As a result, the continuity of the cold chain is often broken through inappropriate handling of cold chain products that require careful temperature control. In addition, not all cold chain stakeholders correctly understand the benefits of cold chains, such as reducing food loss, maintaining quality, and ensuring food safety. It is necessary to raise awareness amongst consumers about the value of cold chain products so that they may become more willing to pay a higher price for cold chain products.

To address these issues, the following measures are recommended to be considered by governments and related stakeholders:

(i) For infrastructure-related issues (e.g. the installation of essential facilities and stable power supply at affordable prices), government initiatives and supports (e.g. tax incentives) should be considered. The introduction of a public–private partnership scheme for the development of cold chain infrastructure is also a potential solution.

(ii) As the development of cold chains is a cross-cutting challenge, the establishment of a specialised institution or a consolidated team that focuses on the development of entire cold chains is desirable. Consolidated national strategies covering all cold chain stakeholders and activities are also needed.

(iii) Regarding human resources development, standardised training for cold chain operators and other stakeholders is essential to improve the quality of cold chains.

In addition,

(iv) To facilitate the engagement of smallholders (e.g. farmers and cooperatives) in cold chains – in other words, to facilitate the development of inclusive cold chains – the development and dissemination of model cases of successful cold chains is effective. At present, smallholders are generally not inclined to use the cold chain as they face many challenges and obstacles to joining the cold chain system. However, learning from successful model cases could help to change their mindset.

(v) Key players in the modern cold chain business in ASEAN tend to be joint ventures with foreign companies that have advanced technologies and skills in terms of cold chain operations. Therefore, the promotion of alliances with foreign companies or the facilitation of foreign investment by cold chain companies could be an effective strategy for developing or strengthening domestic cold chains.

Efforts to Develop a Global Cold Chain: Japan's Case

The cold chain has significantly expanded the range of trade in terms of geographical and temporal aspects for perishable and high-value food and produce. Cold chains are now an integral part of building a global food supply chain.

Japan's Ministry of Land, Infrastructure, Transport and Tourism developed the Vision and Strategy of the ASEAN Smart Cold Chain Plan in 2019, through a series of discussions by an expert working group composed of representatives from related ministries and government organisations, cold chain related enterprises, and academics. The purpose of the vision and strategy is to enable Japanese logistics companies and logistics equipment manufacturers to organically utilise Japan's logistics systems, standards, and technologies to realise high-quality and environmentally friendly cold chains or 'smart cold chains' through the collective efforts of the related Japanese stakeholders, including the public and private sectors, in response to the recent increase in demand for cold chain logistics in AMS. This is an example of a national effort to develop a global food value chain that enhances global trade in food and agricultural products.

Sustainable Food System

In 2021, the United Nations (UN) Food Systems Summit and its Pre-Summit were held in September in New York and in July in Rome, respectively. Head of state, ministers, governments, international organisations, the private sector, non-governmental organisations, and other diverse actors from around the world participated in the global events to leverage the power of food systems to deliver progress on all 17 Sustainable Development Goals (SDGs), by launching new actions, solutions, and strategies.

The summit took place in the context of increasing recognition of the importance of a stable food supply and sustainable agricultural development. The concept of enhancing the sustainability of the food system while reducing greenhouse gas (GHG) emissions has been positioned as a core concept in agricultural policy and government initiatives. Countries and regions, especially those that are developed, have set ambitious targets to reduce GHG emissions and have developed strategies to achieve such targets.

Strategies in Developed Countries

Recognising that climate change and environmental degradation are an existential threat to Europe and the world, the EU set out the European Green Deal in December 2019 to overcome these challenges. This initiative aims to achieve net zero GHG emissions by 2050. As the contribution of the food and agriculture sector to realise the goal, the Farm to Fork Strategy was formulated and published in May 2020 – aiming to make food systems fair, healthy, and environmentally friendly. This strategy comprehensively addresses the challenges of sustainable food systems and recognises the inextricable links between healthy people, healthy societies, and a healthy planet. Under the strategy, the EU set the following numerical goals, amongst others, with a target year of 2030:

- 50% reduction in the overall use and risk of chemical pesticides
- 50% reduction in food waste per capita
- At least a 20% reduction in the use of fertilisers
- 50% reduction in the sales of antimicrobials used in livestock and aquaculture
- At least 25% of agricultural land used for organic farming

In October 2020, the Prime Minister of Japan declared that Japan aims to reduce GHG emissions to zero as a whole by 2050, to realise a carbon-neutral, carbon-free society. To contribute to this effort in terms of the food and agriculture, forestry, and fisheries sectors, the Ministry of Agriculture, Forestry and Fisheries announced the Measures for achievement of Decarbonization and Resilience with Innovation (MeaDRI) in May 2021. MeaDRI, a medium- to long-term strategy, is expected to pave the way towards the development of a sustainable food system by enhancing stakeholder engagement at each stage of food supply chains and by promoting innovation to reduce the environmental load. This strategy aims to achieve the following goals, amongst others:

- Zero CO_2 emissions from the agriculture, forestry, and fisheries sectors by 2050
- 50% reduction in the risk-weighted use of chemical pesticides through the dissemination of integrated pest management and newly developed alternatives by 2050
- 30% reduction in chemical fertiliser use by 2050

- Increase in the organic farming area to 1 million hectares (equivalent to 25% of farmland) by 2050
- At least 30% enhancement in the productivity of food manufacturers by 2030
- Sustainable sourcing for import materials by 2030
- 90% and more superior varieties in forestry seedling
- 100% of artificial seedling rates in aquaculture of Japanese eel, Pacific bluefin

The ministry stressed that these targets will be enabled through the development and dissemination of innovative technologies.

The United States (US) Department of Agriculture published the Agriculture Innovation Agenda in February 2020, which aims to achieve the goal of increasing US agricultural production by 40% while halving the environmental footprint of US agriculture by 2050 through stimulating innovation. The following goals have been set, amongst others, with a focus on technological development:

- 50% reduction in food loss and food waste by 2030
- Strengthen soil health and carbon storage in agriculture by 2050, with a net reduction in the current carbon footprint of agriculture
- 30% reduction of nutrient outflow to water by 2050

Strategies in ASEAN

ASEAN has a comprehensive strategic plan for cooperation in the food, agriculture, and forestry sectors – the Vision and Strategic Plan for ASEAN Cooperation on Food, Agriculture and Forestry, 2016–2025. The plan, adopted by the ASEAN Ministers of Agriculture and Forestry in September 2015, describes strategies for enhancing sustainable agricultural production: (i) enhance the quantity and quality of production with sustainable, 'green' technologies and resource management systems, and minimise pre- and post-harvest losses and waste; and (ii) increase the resilience to climate change, natural disasters, and other shocks. It also covers environmentally friendly activities such as the Good Agricultural Practices; climate-smart and/or friendly agriculture; and collaboration with regional and international bodies to minimise GHG emissions from food, agriculture, and forestry. In addition, the AIFS Framework and SPA-FS, 2021–2025 emphasised enhancing resilience to climate change and increasing sustainable agricultural production and productivity as emerging challenges in food security. Furthermore, introducing climate-smart agriculture was one of the outputs. The ACRF, adopted by the ASEAN Summit in November 2020, stated the importance of investing in sustainable agriculture and food systems. The Implementation Plan of the ACRF cited the need to 'develop and implement ASEAN guidelines for sustainable agriculture' but did not specify a time frame (ASEAN, 2020c: 50).

These key documents show that AMS recognise the importance of sustainable agriculture – specifically, improving agricultural production and productivity while reducing the environmental load. These strategies are not legally binding instruments. It is desirable to set more concrete goals through numerical targets with time frames and to create regional guidance specifying prioritised activities along the food supply chain, to accelerate the realisation of a sustainable agriculture and food system in ASEAN.

Recent Regional Efforts

As a recent interregional effort in Southeast and East Asia to create a sustainable food system, Japan and seven AMS (Cambodia, Lao PDR, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam) released the Joint Statement on Sustainable Agricultural Production and Food System in July 2021 at the Pre-Summit of the UN Food Systems Summit. This joint statement stressed the following points:

- These countries in Monsoon Asia share regional particularities regarding agricultural production, such as the high humidity and temperature climate conditions, an abundance of paddy fields, and a high percentage of small and medium-sized farmers.
- Innovation in agriculture and related industries is key to sustainable agricultural production and food systems, especially for small and medium-sized farmers, and private sector investments need to be encouraged to enhance such innovation.
- International collaboration is important to introduce innovative and sustainable agriculture practices and technologies such as digital tools.
- The statement concludes with a ministerial resolution to promote and deepen collaboration through joint research projects and existing frameworks to achieve a balance between productivity and environmental protection.

It is necessary to promote balanced efforts to improve agricultural productivity and consider the environmental load by utilising regional cooperation frameworks such as the ASEAN Plus Three[3] and the East Asia Summit. Such efforts will contribute to the realisation of a sustainable food system for the region.

[3] ASEAN Plus Three refers to the 10 AMS plus China, Japan, and the Republic of Korea.

Conclusion

As discussed, the food and agriculture sector faces multiple challenges. The acceleration of the increase in the productivity of agriculture and food production is needed to provide sufficient and nutritious food to the growing regional and global population, while the availability of natural resources such as productive agricultural land and fresh water for agriculture is becoming constrained. Recent external shocks – including the disruption of agricultural production and food supply chains due to the COVID-19 pandemic as well as adverse effects on agricultural production by frequent natural disasters such as droughts and floods – have reminded us of the need to enhance the resilience of agricultural production and food supply chains. At the same time, we need to consider increasing food and agricultural production while reducing the environmental load with innovative technologies such as digital technologies.

The ASEAN Guidelines on Promoting the Utilisation of Digital Technologies for ASEAN Food and Agricultural Sector are the first guidance on digitalisation focusing on the food and agriculture sector, and will be a benchmark for digital transformation of the ASEAN food and agriculture sector. In the near future, each AMS may consider formulating a country- and sector-specific road map for the digitalisation of food and agriculture, taking into consideration the domestic agriculture situation and development strategy of each country.

Another important technology for adding value to food and agricultural products while reducing the environmental load is the cold chain system. We should pay attention to the important role of the cold chain system in reducing post-harvest loss and food loss, which results in reducing environmental load. The development of a modern cold chain and the engagement of smallholders face several difficulties in many developing countries. The most important way to change the situation, especially for LDCs, is to showcase a successful model case to convince smallholders and other stakeholders that they could reap multiple benefits from engagement in cold chains. This would raise the awareness of stakeholders about the positive impacts of cold chains and change the mindset of smallholders.

A sustainable food system is one of the key concepts that has been attracting global attention in recent years. There are various important topics around this concept such as smart farming, smart food chains, farming with low GHG emissions, organic farming, a competitive food industry with decarbonised and environmentally friendly technologies, food loss reduction, sustainable sourcing of materials, investment for development, and the diffusion of innovative technologies. Some countries and regions, especially developed countries, have already built comprehensive strategies and plans for building a sustainable food system. ASEAN is expected to develop comprehensive region-specific guidelines, strategies, or plans towards the realisation of a sustainable agriculture and food system in cooperation with dialogue partners and international organisations as needed.

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