ASEAN GUIDELINES ON PROMOTING THE UTILIZATION OF DIGITAL TECHNOLOGIES FOR ASEAN FOOD AND AGRICULTURAL SECTOR

Enhancing Food Supply Chain Resilience and Food Security in ASEAN with Utilization of Digital Technologies
Component 3

Final Draft

June 2021

Table of Contents

Acronyms and Abbreviations

4IR	Fourth Industrial Revolution
ACDS	ASEAN Catch Documentation Scheme
AEC	ASEAN Economic Community
AI	Artificial intelligence
AIFS	ASEAN Integrated Food Security
AMAF	ASEAN Ministers on Agriculture and Forestry
AMS	ASEAN Member States
ASEAN	Association of Southeast Asian Nations
ATWGARD	ASEAN Technical Working Group on Agriculture and Research Development
AusAID	Australian Agency for International Development
COVID-19	Coronavirus disease 2019
E-agriculture	Electronic agriculture
E-commerce	Electronic commerce
FAO	Food and Agriculture Organization of the United Nations
FAS	Food and agricultural sector
FGD	Focus group discussion
FinTech	Financial technology
GDP	Gross domestic product
GIZ	German Agency for International Cooperation
GPS	Global positioning system
ICT	Information and communication technology
IEC	Information, education and communication
IFAD	International Fund for Agriculture and Development
IFPRI	International Food Policy Research Institute
IT	Information technology
JICA	Japan International Cooperation Agency
MSMEs	Micro, small and medium-sized enterprises
OECD	Organisation for Economic Co-operation and Development
OJK	Financial Services Authority of Indonesia

PA	Precision agriculture
R&D	Research and development
SEAFDEC	Southeast Asian Fisheries Development Center
SMEs	Small and medium enterprises
SNKI	National Strategy for Financial Inclusion of Indonesia
SOM	Senior Officials' Meeting
SPA-FS	Strategic Plan of Action on Food Security in the ASEAN Region
UNDP	United Nations Development Program
US$	United States dollars
USAID	United States Agency for International Development

Background

While agriculture continues to provide food and income to families and has generated livelihood and employment to millions, the combined effects of increasing population, limited resources, unprecedented climate change, disasters, and most recently the COVID-19 pandemic, have put so much pressure to the food and agricultural sector (FAS). Thus, it is imperative for the FAS to continually aim for resiliency, productivity, viability and sustainability. One way of achieving these goals is through digital technologies, which have been introduced and widely promoted in the FAS, given their efficiency and productivity enhancing potential. In fact, global introduction and breakthroughs pave the way for a digital agriculture revolution or 'Fourth Industrial Revolution' (4IR), as it is coined, and calls for increased use of current digital technologies (e.g., mobile applications, Precision Agriculture (PA), Artificial Intelligence (AI), e-commerce platforms) to bridge the gap between science and traditional practice in the field, and bring about a revolution that provides food and income security to communities. At the macro level, the use of such new technologies can further ensure productivity, stability and safety across value chains and in various levels of food systems. In the same way, it can be instrumental in the governments' appropriate delivery of services and provision of a digital-enabled policy environment.

Southeast Asia is at the forefront of digital transformation with approximately 340 million internet[1] users in 2019, with four of its ten member states, Indonesia (5th), Vietnam (10th), Philippines (17th), and Thailand (18th) among the top countries with the largest population of internet users in the world. Meanwhile, Singapore is on top in terms of automation or the highest robot density in manufacturing. Valued at US$ 100 billion in 2019, the ASEAN digital economy is expected to reach the US$ 197 billion level or about 87 percent of the region's gross domestic product (GDP) and with the potential to uplift the economy by US$ 1 trillion by 2025, as per ASEAN Secretariat's report.

[1] 2019 World Bank latest data and estimates (http://data.worldbank.org)

Being at the forefront of digital transformation, however, does not spare the region from accompanying challenges. Amid the growing population and limited resources in Southeast Asia, feeding more than 600 million people is a critical concern. Emerging challenges, such as meeting the food and nutritional needs of populations and increasing sustainable agricultural production and productivity, strongly calls for the cooperation of ASEAN Member States (AMSs) to address these issues (Association of Southeast Asian Nations [ASEAN] 2020). In the face of persistent environmental, socio-economic and political threats projected to impact the contributions of the FAS, providing a sustainable food source to families and generating stable livelihoods for rural communities in the region is a priority. Moreover, adjustments to food production will be necessary given the growing consumption demand and the need to adapt to fast-paced changes and developments. These only reflect that despite the initial gains, the benefit of digital transformation is yet to be maximized in the region. More challenges that continue to persist and affect these initial gains include threats of cybersecurity, data privacy and interoperability, economic displacement (labor replacement) and much needed retooling. There is also that risk of driving deeper the digital divide across economies, sectors, groups or genders, given differing levels of development stages, capacities and/or access to resources.

The ASEAN has demonstrated its support through various policy responses and plans on the use of digital technologies and innovations in various sectors, most especially in the FAS. The *ASEAN Economic (AEC) Blueprint 2025* identifies information and communication technology (ICT) as a key driving force in transforming into a digital-enabled economy that will encourage stronger activities in trade, entrepreneurship, and investment (ASEAN 2015b). Complementing this is the *Master Plan on ASEAN Connectivity 2025*, which recognizes digital innovation as one of five key pillars to ensure physical, institutional and people-to-people connectivity in the region. It anticipates as well that digital technologies will have a disruptive effect as well as significant impacts across key sectors, specifically estimating it for agriculture to be US$ 24-48 billion by 2030 (ASEAN 2016).

Most recently, the ASEAN came up with a clear and coherent strategy in support of the 'Fourth Industrial Revolution' (4IR) complete with a coordinated narrative on how it aims to progress digital transformation and embrace new technologies especially in the FAS. In the 2016-2025 Vision And Strategic Plan for ASEAN Cooperation in Food, Agriculture and

Forestry, some important caveats include: (1) strengthening mechanisms, harnessing technology and relying on available infrastructure and institutions to increase resilience and prevent losses due to disasters; (2) promoting joint approaches in technology transfer and knowledge sharing; (3) promoting sustainable and green technologies; and (4) assisting smallholders in small and medium enterprises (SMEs) in the FAS (ASEAN 2015a). These strategies are further strengthened in the: *ASEAN Integrated Food Security (AIFS) Framework and Strategic Plan of Action on Food Security in the ASEAN Region (SPA-FS) 2021-2025,* as AMSs plan to continue providing avenues for information exchange on new technologies, particularly through a technology portal to promote productivity techniques and sustainable practices in agri-based and food value chains (ASEAN 2020); and *Strategic Plan of Action on ASEAN Cooperation in Agricultural Training and Extension (2021-2025)* where identifying infrastructure and technology requirements for capacity building programs on technology adoption, identifying technology success stories, and disseminating information on best practices through digital communication have been highlighted (ASEAN 2021). Additionally, the importance of working towards the prioritization of innovative agriculture through regional cooperation and collaboration in scientific research and technical application for the FAS was emphasized during the Senior Officials' Meeting (SOM) of the ASEAN Ministers on Agriculture and Forestry (AMAF) in 2018.

In the last decade, various studies such as those from the Food and Agriculture Organization and the World Bank (Trendov, Varas, and Zeng 2019); World Bank Group 2019) highlight the potential of digital technologies and innovation to respond to global changes and issues affecting production and resilience of the FAS. The Organization for Economic Co-operation and Development (OECD) (2019) also cited the uses of technology in the FAS, which involve various purposes for data (i.e., data collection, analysis, storage, management, transfer and sharing) as seen in Annex 1.

While currently being used by stakeholders of the FAS in the region, these technologies still have a long way to go in terms of adoption. Even with difficulties in its use and implementation, there have been significant benefits documented by various stakeholders. Digital technologies have ensured efficient and sustainable farm management, thereby ensuring food security in communities. Monitoring tools have also been used to identify risks, as well as climate change impacts that can potentially affect production (Torbick et al. 2017). Digitalization is also seen

to guarantee faster operations across the value chain through evidence-based decision-making for more sustainable production pathways and to minimize barriers that hamper production (Luu et al. 2017; Basso and Antle 2020). In dealing with pressing needs and demands, financial technology (FinTech) has provided agriculture finance strategies that have driven mass-scale capital and loans to be available and more accessible, as well as digital payment systems that have guaranteed smoother transactions and less exposure to risks (McIntosh and Mansini 2018). Digital technologies also support trade for agriculture and food products by connecting private sector suppliers to new markets, enabling new ways for governments to monitor and ensure compliance with standards, and providing faster and more efficient border procedures that are essential for perishable products (OECD, 2019).

The current pandemic situation, where threats of COVID-19 to public and economic health persist, has reshaped the lives of various stakeholders. With millions of people affected, the importance of digitalization has been tested, further highlighting its importance and harnessing its potentials. The use of digital technologies has paved the way to cope with current challenges and negative impacts on the economy. It has bridged the gap to create a digitally-interconnected environment despite area lockdowns and limitations, both in terms of mobility and access to resources. The foregoing reflected how transitioning into a digital-friendly economy afforded opportunities to amply prepare for future disasters or unprecedented shocks and even move towards resiliency. However, the transitioning process is easier said than done, as it is not taking place as quickly as desired. A far-reaching concern is the usual difficulty encountered in moving from digital technology application to full benefit realization stage (i.e., at the business level in terms of enhanced profitability) afforded by the associated cost savings and/or higher income resulting from expanded sales and better prices, usually attributed to digital applications. Thus, the need to look deeper into the issues where insights gained are translated into Guidelines.

The Guidelines recognize that the benefits and accompanying cost of digital technology and innovations vary at the macro, meso and micro level— macro in terms of the interactions at the broadest level, usually national (in case of AMSs) and in terms of required infrastructure and network, overall enabled environment such as institutions, national programs and policies in place, as well as availability of skilled human resources to service the digital application; meso, in terms of community, organization and group levels interactions (i.e. rural/urban

dwellers, women, youth) which are usually in between the macro and micro levels); and micro in terms of interactions within the enterprise level, such as the capacity and knowledge extent of the agricultural enterprises. For the more technology savvy and well-equipped digital users (e.g., medium to large agricultural enterprises), the cost and benefit may easily be determined as digital technology choices and application (even in multiples) are usually done with integration and calculated risks and benefits. The challenge, however, lies more on smallholder agricultural enterprises, where digital use is on a per application basis (either single or multiple but usually unintegrated basis) and where estimation of benefits cannot readily be assessed or factored out, specifically cumulative benefits over a period of time at the whole farm enterprise level.

The Guidelines are intended to aid digital technology users and innovators specifically the FAS stakeholders in the region in making data driven decisions in their choices, utilization and assessment of digital technologies. Likewise, it is also for the AMSs in their bid to maximize the use of digital technologies in enhancing service delivery towards a resilient, productive and sustainable FAS in the region.

Objectives and Orientation

The ASEAN economy, valued at US$100 billion in 2019, has the potential to uplift the economy by US$1 trillion by 2025. To further strengthen current strategies in place with future scenarios in mind, the ASEAN saw the need to conduct a study on enhancing food supply chain resilience and food security in the region with the utilization of digital technologies. The study aims to consolidate the information on the utilization status of digital technologies that have the potential to increase farm productivity and improve the resiliency of the supply value chain, and to formulate a set of guidelines on the utilization of digital technologies for the FAS.

The regional Guidelines will equip the ASEAN with recommendations and implementation considerations for making an informed decision that will shape agriculture's digital transformation in the region. More specifically, the Guidelines will outline conditions and actions needed to make use of digital technologies for agriculture and food system improvements, including interventions to facilitate digital technology uptake in the FAS.

In order to gain more insights on the use of digital technologies on the ground, a focus group discussion (FGD) through an online knowledge workshop, as well as scoping survey were conducted with relevant representatives of AMSs. The first knowledge sharing workshop gave an overview of the available digital technologies in each country and solicited key insights on issues and factors to improve the enabling environment of digitalization in the FAS. Meanwhile, the scoping survey provided more context on the discussions during the workshop through insights gathered from users and presumed users as well as other stakeholders (e.g., technology developers, policymakers, and consumers) on the use of digital technology and its applications in agriculture, and the process of adopting digital technologies from the initial processes, promotion, to the actual adoption. It further delved into information on the level of understanding of respondents, as well as related activities undertaken to prepare users to adapt digitalization in their everyday tasks (Annex 2).

Scope and Definitions

The ASEAN Guidelines on Promoting the Utilization of Digital Technologies for ASEAN Food and Agricultural Sector enumerates key steps that will steer AMSs and various stakeholders towards planning for a more digital-friendly environment in the FAS. In particular, this document will be helpful for those that are affected and potentially impacted by digitalization in the sector such as: farmers, fisherfolks and other agricultural workers; digital technology initiators; policymakers; and other stakeholders such as the academe, industry and NGOs. Central to the effective and successful operationalization of the Guidelines will be the active participation and cooperation of AMS governments as initiators of policies and programs. The ASEAN Technical Working Group on Agriculture and Research Development will likewise play an important role in translating the Guidelines into evidenced-based plans of action and policies. It will also lead to ensuring that initiatives and programs are monitored in terms of their progress and contribution to digitalization in the FAS.

The Guidelines supplement policy initiatives and strategies of ASEAN on strengthening ICT and prioritizing digital innovation, which eventually benefits innovations in the FAS. It uses the perspective of AMSs in gathering insights and drawing conclusions on how digital transformation can be best implemented in the region. Moreover, the Guidelines is envisioned to be aligned with and to complement existing national agricultural goals and priorities. Through the conduct of consultations and surveys, the Guidelines referred to country and regional experiences to reflect the current situation and takes into account future challenges in the digital transformation in the sector. Further, these recommendations were formulated mainly from the digitalization lens, while keeping in mind the needs of users and the relevant issues that policymakers and organizations should address along the way.

The Guidelines are anchored on existing international concepts, knowledge, and strategies that relate to the use of digital technologies in the context of FAS. For this document, the following terminologies are used:

- **Digital technologies.** The World Bank Group (2019) defines digital technologies as "tools that collect, store, analyze, and share information digitally, including mobile phones and the Internet". As viewed by representatives of AMSs attribute digital technologies to

computers, electronic systems and tools, and online platforms and databases for their collection, analysis, storage, and sharing of data in the context of FAS.

- **E-agriculture**. Also called smart farming or digital agriculture, e-agriculture "involves designing, developing and applying innovative ways to use ICTs, including digital technologies - in the rural domain, with a primary focus on agriculture, including fisheries, forestry and livestock." (Food and Agriculture Organization of the United Nations [FAO] 2017)
- **Food and agricultural sector (FAS)**. ASEAN agriculture comprises crops, fisheries, and livestock sub-sector. On a larger scale, the sector considers the entire food system, including food producers, manufacturers, traders, processors and all actors in the value chain.
- **Food security**. As defined in the World Food Summit of 1996, food security exists "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". FAO (2006) also states the four (4) dimensions of food security namely: food availability, food access, utilization, and stability.
- **Food systems**. These 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. (International Food Policy Research Institute [IFPRI] n.d.)
- **Producer.** In the FAS, a producer is involved in farming, fishing, or in any business that involves the production, supply and marketing of food.
- **Private sector.** The private sector includes micro, small and medium-sized enterprises (MSMEs) and large companies involved in the food and agriculture businesses.
- **Rural Transformation.** A process of comprehensive societal change whereby rural societies diversify their economies and reduce their reliance on agriculture; become dependent on distant places to trade and to acquire goods, services, and ideas; to effectively address the process of rural transformation, a higher level of policy coherence between the desired overall development path and agriculture, food security and nutrition policies will be required. (Berdegué, Rosada, and Bebbington 2014)

Accelerating Transformation of the ASEAN Food and Agricultural Sector (FAS) through Digital Technologies and Innovations and its Challenges

Embracing new technologies in the FAS has demonstrated benefits in terms of production efficiency, resilient production systems, and better resource management; the same way that it led to the realization of numerous challenges accompanying digital utilization and its potential maximization. It is seen to have impending impacts related to data and cybersecurity, labor replacement, re-education, as well as varying skills and capacity for technological adaptability, among others. The need for technological advancement has never been greater given disruptions in Southeast Asia's food systems. Thus, pushing for nurturing it further and maximizing its gains in the FAS has been an urgent matter as it impacts varying issues such as food security and needed infrastructure, digital literacy, and technology adoption support.

Food security

Recent World Bank[2] data reveal that approximately 111 million people, or 18.5% of the world's moderately or severely food insecure people come from Southeast Asia. This is why building and maintaining resilient food systems that ensures consistent food production at minimum risks has become a daunting challenge so as to feed a regional population of 600 million people. Other equally significant factors that continue to disrupt food production and that have pushed people to hunger have been identified (Husain et al. 2020):

1. *Dwindling resources*. For example, the percentage of arable land to total land area has decreased by 4.8% between 2009 to 2018[3].
2. *Climate change factors and disaster occurrences*. Four out of the ten most vulnerable countries (i.e., Myanmar, Philippines, Vietnam and Thailand) in the world are in Southeast Asia (Eckstein et al. 2020, as cited in Pulhin et al. 2020). Southeast Asia is likewise the most disaster-stricken region in the world, with 529 occurrences

[2] World Bank latest data on prevalence of moderate or severe food insecurity in the population (https://data.worldbank.org/indicator/SN.ITK.MSFI.ZS)
[3] World Bank latest data on arable land (% of land area) [https://data.worldbank.org/indicator/AG.LND.ARBL.ZS]

for the 2009 to 2019 period, and accounting for 14% of the world's total disasters (Annex 3-Figure 1).

3. *Political (conflict) and economic (GDP) downturns*. With 118 conflict occurrences from 2009 to 2019, the region accounts for 7% of the world's total. Political unrests or conflicts, like the case of Myanmar, has impacted economic growth and has put more people at risk of being food insecure (Annex 3-Figure 2 and 3).

To unleash potentials and avail of more opportunities akin to digital technologies and innovations in the FAS, it is vital that conditions both basic (e.g., infrastructure and connectivity, affordability, education, institutional support) and enabling (e.g., use of internet and mobile and social networks, digital skills, encouraging digital culture) are in place (Trendov, Varas, and Zeng 2019). Yet, in some AMS in the ASEAN region, these basic and enabling conditions are still wanting and as such, hamper the adoption and utilization rate of digital technologies. In terms of key infrastructure indicators, Cambodia, Lao PDR, and Myanmar are seen to lag behind neighbors, in terms of access to internet, electricity, and mobile phones (Annex 3, Figures 4-6).

Connecting agricultural communities through infrastructure

Mia and Habaradas (2020) also noted the large discrepancies among AMSs in terms of the current conditions of digitalization infrastructure and knowledge: Singapore, Brunei, and Malaysia are at the forefront of digitalization; Indonesia, Thailand, Vietnam, and the Philippines have made crucial steps to develop infrastructure towards a digital economy; and Cambodia, Myanmar, and Lao PDR have just started to bridge policy gaps to support the development of ICTs. The gaps in the digitalization capacity level of AMSs is also further evidenced in the Global Connectivity Index 2020, which monitors the "relationship between ICT infrastructure investment and economic growth" in 75 countries, and scores them "according to their level of ICT investment, maturity, and economic development" (Huawei 2020). In the report, five (5) AMSs were included: Singapore, classified as a frontrunner (i.e., developed economies with high investments in technologies); Malaysia and Vietnam, classified as adopters (i.e., countries with high growth rates mainly attributable to their ICT infrastructure investment); and Indonesia and the Philippines, classified as starters (i.e., countries that are at the initial stage of its ICT infrastructure investment). Moreover, delving deeper into the contribution of GDP

to a country's accessibility to technologies, World Bank data show that AMSs with higher GDP per capita such as Singapore, Brunei, and Malaysia have more than 80 percent of their population with access to the internet, while lower income economies like Cambodia, Lao PDR, and Myanmar are only at the 20 percent-30 percent level (Annex 3, Figure 7).

Digital literacy and technology adoption

Nine new technology-adoption influencing factors, namely, human capital and farm household characteristics, farm size, farmer financial resources, social capital, extension, risk and risk preference, agro-ecological factors, input-output factors, and market access, have been suggested (Luu et al. 2017) . Further, Alexander et al. (2020) argue that the capacity and attitude of farmers will play a significant role in the acceptance and adoption of technologies in their activities. Given their knowledge on traditional techniques, there will be farmers who will need more technical assistance on new technologies, and those who will be reluctant to recognize the advantages brought about by these innovations.

Moreover, digital literacy of key actors will also be crucial especially that most users lack exposure to technology due to age, socio-economic background (Asvanund 2016; Sayruamyat and Nadee 2020) or lack of education IICA, IDB and Microsoft (2021) affecting basic skills such as reading and writing . To ensure that technological advancement is pursued especially in rural areas, the support of various government, private sector and other organizations for digital education and training have repeatedly been emphasized. Hence, there is undeniably a need to prevent the widening of the digital divide (OECD 2001; World Bank Group 2019), not only among AMSs, but also among people with varying abilities to access and use available and affordable technologies.

While there are persistent issues that impede digital transformation in the FAS, it is also important to note how these challenges have been overcome through innovations, policies, and programs. The following examples are some of the best practices of AMSs worth noting to distill information and provide lessons learned moving forward.

Providing market access to farmers through online platforms amid the COVID-19 pandemic

Box 1. Rural Rising, Philippines

Rural Rising is a social enterprise that has catered to farmers who have been greatly impacted by the COVID-19 pandemic. Due to limited mobility and area lockdowns, farmers have found it difficult to sell their produce due to limited market access and lower demand as several restaurants have been closed. As some produce are left to rot, some middlemen have taken advantage of the situation by buying them at very low prices, leaving farmers to lose a big part of their income. To help the farmers, Rural Rising, together with conglomerate San Miguel Corporation, have launched 'rescue buys' where they search for farmers who have no buyers for tons of fruits and vegetables at the brink of spoilage. The produce are bought at fair prices, transported to Metro Manila, and marketed through their two (2) online platforms- a website and a Facebook page. Since the start of the Philippine community quarantine in March 2020, Rural Rising and its partners have been helpful for farmers in distress and have greatly helped consumers to have access to fresh produce at affordable prices. Moreover, some of the produce have also been donated to soup kitchens, local food banks, and families who have lost their jobs because of the pandemic. The initiative is worth-noting as it highlights the power of 'bayanihan' (communal unity) spirit, while empowering farmers and harnessing the growth potentials of rural areas.

Source: ("Rural Rising Philippines," n.d.)

Digital farming solutions

Box 2. Intel's Grameen Social Business, Ltd and the International Fund for Agriculture and Development (IFAD), Cambodia

Cambodia, one of the biggest rice-producing countries in ASEAN and in the world, has benefited from the support and funding of Intel's Grameen Social Business and the International Fund for Agriculture and Development (IFAD). Farming solutions for precision agriculture and science-based farming ensure production efficiency and food security. Using Intel's farming app called 'e-Agro suite', farmers are able to collect data, such as soil samples, GPS data and environmental data, and are given real-time advice and recommendations based on the current status of their farms. This technology is also available to farmers remotely, thereby reducing transportation and logistics costs.

Source: Supporting Economic Transformation (2020)

Digital innovations in the livestock sector

Box 3. Charoen Pokphand Group, Thailand

Charaoen Pokphand (CP) Group, Thailand's leading agri-business conglomerate, supports the transformation of Thai agricultural systems through digital technologies. The company has ventured into applying technologies in their processes and forging partnerships with international key players to improve their production. Moreover, it believes in contributing to the continuing development of the FAS in Thailand, while taking into consideration other important issues on sustainability and mutual benefiting of stakeholders.

Charoen Pokphand Foods, a sub-unit of CP Group, currently uses artificial intelligence in its hog farms in Nakhon Pathom Province. The application has the following features: (1) notification on unauthorized entries especially for those without proper sanitation and hygiene according to plant standards, which can eventually be used to prevent or track any animal disease transmissions; and (2) monitor the activities of hogs remotely.

Source: Charoen Pokphand Group (2018); Onishi and Kishimoto (2019)

Digital marketing solutions in the agri-food sector

Box 4. E-commerce platforms in Malaysia

Malaysia has driven the enhancement and improvement of its digital infrastructure through the 10th Malaysia Plan (2011-2015) and 11th Malaysia Plan (216-2020), which laid out plans for digital transformation in the country. This has been evident in various statistics, e.g., with Malaysia ranked third out of ten ASEAN countries, with 81 percent of the population using the internet. Taking full advantage of the developments in its digital economy, the Ministry of Agriculture and Agro-based Industry has pushed for initiatives on the utilization of farm technologies and digital solutions for supply chains actors. For example, the online marketplace 'AgroBazaar Online' (http://www.agrobazaar.com.my) was launched in 2014 to link producers to more customers and offer local agricultural products to consumers. Since then, the government has seen this as a new prospect for small and medium enterprises (SMEs) to expand and widen their market reach. To further assist SMEs, the government committed RM700 million in its budget for the Economic Recovery Plan to take advantage of the growing e-commerce industry. To supplement current initiatives, Malaysia recently engaged its private sector partner AirAsia for 'Ourfarm', a business e-platform intended to link farmers to businesses and industries. This initiative has proven to significantly help farmers in terms of marketing their products and improving their income, especially as they recover from the impacts of the COVID-19 pandemic to their livelihoods.

Source: Safari and Ngusman 2019; Habibu 2020

Financial inclusion in the FAS

Box 5. Food ACTION (Acceleration-Synergy-Financial Inclusion) of the Financial Services Authority of Indonesia

As part of the Indonesian government's National Strategy for Financial Inclusion (SNKI), the Food ACTION program promotes public-private sector collaboration in order to ensure food security and financial inclusion. With the plan to make financing accessible and available for the agriculture sector, specifically for 11 identified products, the program also envisions to be a "national movement that will introduce and implement the value-chain financing scheme". Government ministries have forged partnerships with the financial sector, most especially banks and fintech companies, to support the program implementation using the value-chain financing model, where credit, loans, and insurance products are easier to access. IT applications have also been set up to assist users not only in production but also in improving their financial literacy and skills.

Source: Financial Services Authority (OJK) of Indonesia (2017)

Multisector partnerships in urban high technology food sector

Box 6. AgriTech Ecosystem of Singapore

With only less than 1 percent of land classified for agricultural and less than 10 percent of food locally produced to feed a population of almost 6 million people, Singapore's food security and sufficiency levels are immensely exposed to external risks and shocks. To safeguard its food supply given vulnerable conditions especially with recent COVID-19 pandemic-related global economy disruptions, the Singapore government, through the Singapore Food Agency, has targeted to increase its local produce of its nutritional needs to 30 percent by 2030. To address this looming issue, it has also launched various programs with the help of the private sector, the academe, and civil society. Further, the government has demonstrated strong commitment to fund research and development (R&D) programs (e.g., Research Innovation Enterprise Plan 2020 with $105 million funding) and invest in high technology food production (e.g., investments in Bowery Farms, which has know-hows on robotics and indoor farming; and for an 18ha Agri-Food Innovation Park). With the aim of driving more investors into the AgriTech field, it has started working with private sector partners to fund local agri-food tech start-up companies. Recently, it has also forged partnerships with two local research institutions, Nanyang Technological University and Temasek Polytechnic, in training farmers, and providing science-based insights to address agricultural production issues. International organizations such as the United Nations Development Program (UNDP) through its Global Center for Technology, Innovation, and Sustainable Development are also assisting Singapore and leveraging on its current AgriTech ecosystem and excellent digital friendly enabling environment.

Source: Singapore Food Agency n.d.; UNDP 2019

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

The sustainability of food and agricultural systems is a must if we look forward to our future and those of generations after us. Promoting sustainable systems worldwide, and in the ASEAN region in particular, will reduce the number of poor and hungry, help combat climate change and preserve our natural resources for future generations (Trendov, Varas, and Zeng 2019).

Efficient food systems including resilient value are important to ensure food security, food safety, and nutrition. The use of digital technologies by our producers and agricultural workers ensures that inputs and other resources are effectively managed and guides them in making precise, science-based decisions in production.

Guideline 1: Contribute to food security, food safety and nutrition by improving the value chains (production, post production, market access/linkages and value addition)

Promoting the Utilization of Digital Technologies in improving the value chains within the FAS contributes to achievement of policy objectives such as food security, food safety, nutrition, income growth, sustainable food system in ASEAN by:

i. Appropriately assessing agricultural product's suitability (crop, livestock, and fishery) to location or specific land/water type leads to risk and loss/wastage reduction, higher production and sustainability due to enhanced efficiency.
    - Crops: high accuracy maps on land suitability, soil erodibility (erosion prediction) and soil nutrient availability, derived from spatial data and its ground truth on soil characteristics, land form and climate dynamic, and satellite systems (e.g., remote sensing technology) on the selection of better locations for particular crops given particular land conditions.
    - Aquaculture: water sensors to reduce manpower reliance to collect data.
    - Land suitability mapping for livestock production: digitalization data sharing.

ii. Conducting real time data monitoring (i.e., location, population, and movement) and analysis to ensure accessibility, availability, and operational efficiency, as well as to support sustainability.
    - Fisheries: real-time data monitoring of sea biota location, population, and dynamic movement to control harvest and support sustainability, water sensors to reduce manpower reliance to collect data.
    - Livestock: number population belonging to smallholder farmer and private in each island helps ensure meat accessibility and availability.
    - Affords operational efficiency leading to manpower reduction and waste elimination.
iii. Gathering information that help anticipate abnormalities, shocks, enables adoption of countermeasures that reduces risks as well as impacts and even enhances resilience.
    - Up-to-date weather information through digital gadgets enable farmers and fishermen to brace themselves and prepare better for calamities and weather-related risks.
    - Information on disease outbreaks in specific locations help prevent and control transboundary animal diseases
    - Trainings on digital health clinics to provide health solutions for livestock.
    - Data analysis and application help achieve appropriate scale and market incentives as well as control of product processes and ensure sustainability and resource protection.
iv. Using digital applications in supply chain management, as it not only affords buyer-seller connectivity, but also fosters production, marketing and distribution efficiency that could empower smallholder farmers.
    - Digitalization-enabled trading (e.g., mobile phone payment receipt) affords expanded access to markets and makes them well-equipped in credit application and trading activities in the future.
    - Farmers' greater incentive to boost their productivity, from profitability standpoint; Incentives on greater adoption of technologies.
    - Supply-chain digitalization, i.e., e-commerce, provides an opportunity to eliminate the middlemen.
    - Information through mobile phones enable farmers to compare prices and prevent them from being taken advantage of by middlemen.

To achieve this, the AMS may consider:

a) Institutionalizing a country program or national e-agriculture vision on food and agriculture systems investments (e.g., infrastructure, R&D, digitalization, skills development) with priority agricultural value chains identified and with resultant gains (production and trade) appropriately ensured and monitored.
    - Pursue capacity building trainings/agri-extension services, e-commerce, use of mobile applications in FAS such as, but not limited to, the following:
        - How-tos in accessing and utilizing information that are crucial for farmers in making informed decisions related to preparedness, resiliency and income enhancing.
        - Safe and prudent use of digital technologies.

b) Investing in enhancing data capture, analysis, and utilization in support of commodity-location suitability assessment, including high accuracy maps, real time data monitoring (e.g., sea biota location population and movement in case of fisheries, livestock number and population, crop availability/volume, for supply accessibility and availability purposes).

c) Having a continuing R&D program in satellite technology, biotechnology, nanotechnology, and robotics, which when properly deployed, can enormously improve understanding of animal and plant diseases and even life cycles, leading to more productive and sustainable practices.

d) Out scaling and upscaling breakthrough innovations and technologies as appropriate along the value chain, to enhance knowledge and application and promote sustainable practices.

e) Providing an enabled business environment that encourages healthy competition and incentivizes innovation towards a more resource-efficient and sustainable FAS. Also reviewing policies on FAS, as to the relevance (some are already decades old) and functionality (e.g., regulatory impact assessment), to help level up policies and regulations to the needs of times and enhance ease of doing business.

f) Optimizing the agricultural science and technology services by guiding farmers on how to use information technology to facilitate agricultural production work and market information such as the supply of agricultural materials, resource utilization of waste, agricultural machinery operations, processing of agricultural products, tailored agrometeorological solutions, and agricultural product traceability.

g) Putting in place safety measures to ensure the security of information amidst growing digitalization in FAS.
h) Fostering "food diplomacy" and best-practice sharing in technology across the region, to boost regional productivity and create new food baskets and new food sources to import from.

Building and improving infrastructure to provide a digitally-interconnected environment for the financial use of current and prospective users is crucial. Financial safeguards ensure that existing inequalities in terms of access to loans and ability to perform e-banking transactions are not further aggravated. Moreover, regulations should be in place to avoid a risk-prone digital financial environment. Investments and proper planning from the government and its partners to build infrastructure and improve accessibility, availability, and affordability of digital technologies will be key to create a stronger and more friendly digitally-enabled ecosystem.

Guideline 2: Support equitable, sustainable, and inclusive economic development in FAS and ensure much-needed investment on infrastructure and related support services (e.g., digital banking, accounting and investment for access to loans, microfinancing, reporting)

Promoting the Utilization of Digital Technologies in FAS contributes to equitable, sustainable, and inclusive economic development and ensures much-needed investment on infrastructure and related support services (e.g., digital banking, accounting, and investment for access to loans, microfinancing, reporting) by:

i. Ensuring that digital technologies are usable and include adaptive features to accommodate the needs of new and aging users.
ii. Putting in place appropriate ICT infrastructure that will ensure access to electronic devices especially in remote areas, where a wide range of improvements are needed to cater to the rural population.
iii. Making financial and in-kind support readily available, and loans more accessible to provide capital to smallholders and assist them in their initial costs, given that the use of technologies is an added cost that can potentially burden small-scale farmers.

iv. Working towards a balanced digital infrastructure provision as several sectors, areas, and countries are still underserved by digital agriculture services.
v. Developing and implementing training and capacity building programs and agri-extension services, depending upon requirements, as inequality exists across areas and across users.
vi. Promoting responsible business and financial investment for the expansion of digital rural agriculture, with reference and guidance from the ASEAN Guidelines on Promoting Responsible Investment in Food, Agriculture and Forestry, which provides broad parameters in assessing the application of responsible agricultural investment.
vii. Taking full advantage of existing digital platforms and tools for promoting government guidance, market leadership and access, and social participation.

To achieve this, the AMS may consider:

a) Conducting assessments of electricity and internet access in key rural agricultural production areas, for focused infrastructure investment.
b) Building/enhancing ICTs infrastructure as needed and accelerating its development especially in rural areas, to enhance digital interconnectivity environment, not only with current users in mind but with prospective users as well, for proper volume and accessibility planning as well as for affordability-barrier reduction.
c) Tapping funding such as the Universal Service Fund, among others.
d) Studying the replication of high e-commerce activities in the non-food sector, to replicate in the food sector, even initial successes within the more developed agricultural areas.
e) Building upon existing or developing new appropriate digital platforms where food systems stakeholders are registered participants (e.g., farmers, extension workers, information/service providers, buyers) may exchange information, transact business, provide support services and even secure credit.
f) Exploring the possibility to develop a data linkage platform that will enable data sharing among various platforms with different formats such as digitized weather information, agricultural land information, and data generated by various agricultural digital equipment.
g) Collecting and selecting the suitable contents of data to be shared through digital data platform.

h) Setting up windows of assistance (i.e., for affordable credit) to make technologies more accessible and affordable.

i) Developing programs that will clearly define farmers' role in the increasing digitalization initiative.
    - They may have to give up some "long used to" activities, but it need to be made clear that new activities (e.g., systems improvement, monitoring, and change documentation) to undertake are usually important and likewise made easier.

j) Ensuring government extension services include the provision of support to farmers and MSMEs in digitally adapting their food businesses to the new normal: entrepreneurial education, receiving mobile payments, information on current e-commerce platforms.

k) Conducting consultations with the private sector on specific digitalization related challenges encountered in entering specific markets.
    - Assessment per crop per market
    - Private sector: Off takers, e-commerce providers

l) Conducting assessment of electricity and internet access in key rural agricultural production areas for focused infrastructure investment.

Farmers and producers should be equipped with the ability and knowledge to improve production and post-production processes for better marketability and more sustainable and efficient use of resources. Digital technologies will be a big help in better farm-to-market linkages to attain maximum benefits for producers while expanding their market reach, and in ensuring safe and quality processes while catering to the needs of consumers.

Guideline 3: Support the generation and diffusion of appropriate digital innovations for resource-efficient, sustainable and safe FAS

Promoting the Utilization of Digital Technologies in FAS to contribute to the generation and diffusion of appropriate digital innovations that contribute to resource-efficient, sustainable and safe FAS by:

i. Putting in place a functional traceability system for easier and speedy identification of food safety and fraud risks.

ii. Ensuring that the promise of convenience and efficiency of digital applications are delivered to attract entrepreneurs and facilitate growth of entrepreneurship in agriculture.
iii. Ensuring that digitalization will deliver as expected particularly when target users are not yet well equipped to adopt.
iv. Further studying ways of determining and measuring farmers' profitability and documenting evidences that livelihood will be improved by use of digital technologies such as business viability assessments, among others (as this is currently lacking).
v. Putting in place data security measures, as there is high possibility of data theft, like added layers of security, specifically for online transactions and for cases where targeted users (farmers in particular) are not well-versed on this.
vi. Enabling the development of a dynamic and robust agri-food technological ecosystem where SMEs and startups can also compete and develop, and end-users (e.g., farmers and cooperatives) can have the freedom to choose technological tools and solutions they believe most suited to their needs within the market.
vii. Supporting copyright including patent issues on all digital innovation product.
viii. Ensure proper infrastructure to maintain big data.

To achieve this, the AMS may consider:

a) Knowing and understanding your market well in planning for the more appropriate digital programs for smallholder agriculture.
    - Study smallholder farmers' daily routine and the most critical activities therein.
    - What are the identified benefits of the digital technology intended and how such benefits can be translated into benefits to their daily routine?
    - How can such benefits be concretized and translated into incentives good enough for technology adoption?
b) Establishing a link between digital technology adoption and entrepreneurial gains, to help enhance digital utilization while enhancing enterprise development.
c) Holding dialogues with development partners as well as the private sector to identify how to efficiently deploy capital to eliminate redundancies.
    - Development partners: Examples include AusAID, GIZ, JICA, USAID as well as FAO.
    - Private Sector: Off takers

d) Exploring "online-offline" modes of delivering extension services.
    - While finding new technologies is good, there is a need to focus on scaling up the adoption of those already available.
    - Online: Applications developed by the private sector, including social media applications and farmer peer- to-peer networks for best-practice sharing.
    - Offline: Importance of trust. Leveraging cooperatives, village heads, village-level collectors or distributors of crops to encourage farmers to adopt better technologies.
e) Specifically conducting business-model assessments of scaling viability for existing initiatives (including farmer's adoption and profitability).
    - Conduct crop-specific + market-specific assessments.
    - Conduct consultations with the private sector on challenges faced in scaling private sector technologies.
f) Creating a harmonized standard for classifying data applications in agriculture to increase market transparency.
g) Developing a harmonized language for interoperability across data applications in collaboration with the private sector.
    - Developing an inventory of languages used across data applications.
    - Conducting harmonizing sessions for interoperability.

As digital technologies are more widely used, the possibility of vulnerable sectors finding it difficult to adopt becomes significantly high. Digital technologies are not meant to widen the current gap and further benefit expert users while others are left behind. Hence, policies and programs that will be implemented are crucial in providing equal opportunities and equitable benefits to stakeholders in the FAS.

Guideline 4:Foster capacity building engagement and empowerment especially for the youth, women, and marginalized groups

Promoting the Utilization of Digital Technologies in FAS to contribute to the capacity building, engagement, and empowerment especially for the youth, women, and marginalized groups by:

i. Developing the programs of digital literacy training where users can equip themselves with needed information that will enable them adapt to fast-paced changes in the environment and society.

ii. Ensuring that more than the number, digital initiatives should be appropriate in terms of scale and process of adoption
iii. Farmers have limited "freedom to operate" with data across multiple data service providers.
iv. Addressing issues on inequality and inequity through capacity-building programs, as well as information, education and communication (IEC) campaigns through collaborations with non-government organizations and the private sector that are imperative to level the playing field.
v. Empowering vulnerable sectors and providing more learning opportunities to help overcome challenges especially on their current knowledge and technical abilities.
vi. Considering displacement of workers as an issue that needs addressing in the implementation of digitalization
vii. Consolidating the role of young people and women as agents of change and improving the knowledge exchange process between farmers on the application of digitalization in agriculture.

To achieve this, the AMS may consider:

a) Tapping local universities in advising farmers on production and in-training farmer entrepreneurs, to supplement the work of agriculture extension departments/agencies.
b) Conducting public opinion surveys, interviews, and focus group discussions to consult different populations, especially the youth, women, and marginalized groups about their risk perception of the digital technologies to understand how these groups define the benefits and risks of adopting technologies.
c) Conducting public deliberation events regularly to invite marginalized groups and people from the rural areas to raise their suggestions about how to improve the current sustainability levels of food systems and resilience programs.
d) Including investments on individual or institutional competency development as both have to keep up with the increasing digitalization in agriculture.
e) Conducting on-site demonstration to allow farmers to have a first-hand experience on the application of suitable digital technologies and to provide information on the benefits of using these tools and systems in their production and processes.

The FAS has been bearing the impacts of climate change and disaster risks especially with Southeast Asia as one of the most vulnerable regions in the world. To add to the brunt of these external factors and shocks, the COVID-19 pandemic has caused uncertainty to food systems and disruptions to value chains at both the country and regional level. While these crises and risks have varying effects to different population groups, greater impacts have been seen and recorded for the marginalized and vulnerable sectors. Digital technologies such as the use of mobile phones and online platforms for communication and marketing, and e-wallets and online banking for financial transactions can help farmers and agricultural workers to stay connected to their consumers and adapt to challenges even in the face of health crises and unforeseen events.

Guideline 5: Improve FAS resiliency during disruptions caused by unprecedented events and shocks

Promoting the Utilization of Digital Technologies in FAS contribute to the improvement of FAS resiliency during disruptions caused by unprecedented events and shocks by:

i. Maximizing beneficial applications of digital technologies in quick/emergency response, timely information delivery, early warning systems, remote monitoring and meetings, safe distributions of products, and use of e-commerce, and in the process ensure resilience during pandemics or disasters.
ii. Training more people displaced by technologies to be better equipped in preparation for future pandemics or crises.
iii. Pushing for expanded use as early warning tools, not only for anticipated disasters, but also for possible infestations and nutrient deficiencies based on pre-identified signs or symptoms in advisory services, as well as in more specific applications such as agrometeorology and precision agriculture tools.
iv. Providing customized data in a timely manner as the technology generates them, if usefulness and application are the name of the game.

To achieve this, the AMS may consider:

a) Formulating and promoting regional capacity-building program on enhancing country preparedness in dealing with unprecedented disruptions and shocks (with representatives from each AMS as participants), with the end in view of enhancing or developing a national resiliency program for each AMS.

b) Urging each AMS to have an agriculture response platform for a new normal given the challenges brought about by the COVID-19 pandemic that will help revitalize the FAS, complete with measurable targets and monitoring mechanism (this is presupposing that each has already undertaken studies/documentation of COVID-19 in their respective agricultural sector).
c) Incorporating labor displacement countermeasures, in each program on digitalization in agriculture to reduce setback and fully attain anticipated benefits of digital innovations.
d) Including resiliency measures amidst unanticipated disruptions and shocks through digital technologies as a component of R&D investments.
e) Ensuring digital interventions support for the generation of localized information (in addition to aggregated ones) towards an informed decision-making process that will enhance the usefulness of digital interventions.
f) Launching campaigns, programs and conducting trainings to encourage urban farming

The ASEAN's motto of 'One Vision, One Identity, One Community' fully embodies the importance of regional cooperation and multilateral relations in today's globalized world. More activities and stronger policies on knowledge generation and information exchange across countries would be pivotal in ensuring that opportunities presented by digital innovations in the FAS are tapped and maximized. These efforts, even with threats of fast-paced changes and new technological demands, will help improve the FAS in bringing inclusive development and sustainable economic growth in the region.

Guideline 6: Strengthen regional partnerships/approaches for digital innovations in the FAS

Promoting the Utilization of Digital Technologies in FAS strengthens regional partnerships/approaches for digital innovations by:

i. Increasing regional collaboration to assist countries that are trailing behind in terms of digital innovations and applications or adoption of technologies.
ii. Encouraging sharing of best practices and continuous dialogue to ensure that issues are addressed and benefits from digital technologies are maximized in the entire region.

iii. Identifying key success factors of digital innovation that have benefitted from the ASEAN Economic Integration, such as the ASEAN Catch Documentation Scheme (ACDS) under the Southeast Asian Fisheries Development Center (SEAFDEC).
iv. Exploring more avenues for wider adoption of existing digital applications such as the ACDS.
v. Promoting interregional cooperation and collaboration with international organizations that utilizes various frameworks such as ASEAN Plus Three.
vi. Engaging multisectoral stakeholders' involvement for successful digital intervention in agriculture.

To achieve this, the AMS may consider

a) Establishing a regional or subregional platform among AMSs that will identify common priorities in the digitalization of agriculture (including responses to COVID-19 pandemic) and together, planning and implementing collective actions, where each initiative will help solidify subregional partnerships.
b) Clearly identifying individual sectors' strength and potential roles in digital innovation in agriculture, and then build upon that knowledge to entice involvement in possible partnerships.
c) Engaging the involvement of private and civil society groups in introducing digital technologies (probably the private sector) and in promoting digital literacy, familiarity, use and application (civil society).
d) Engaging "Quad-Partnerships" for e-commerce + agricultural extension
    - Private Sector: Provides capital, e-commerce tools, and advice to farmers on business development.
    - Local Universities/Research Centers: Provides technical support and knowledge on growing crops.
    - Government: provides operational support, policy incentives, operational guarantees, supervision, management
    - Farmer cooperatives: Organize farmers and create an organization for "farming as a business".
e) Conducting dialogues with development partners as well as the private sector to identify how to efficiently deploy capital to eliminate redundancies.

- Development partners: Examples include AusAID, GIZ, JICA, USAID as well as FAO
- Private Sector: Off takers, platform owners, digital service providers, mobile network operators

Roles and Responsibilities of Stakeholders

Advocating for the utilization of digital technologies in FAS is a regional priority. It is a shared responsibility that does not involve governments alone, but entails the collaborative efforts and cooperation of producers and technology users (e.g., farmers, fisherfolks, other producers); financial and lending institutions; researchers and the academe; agribusinesses and industries; and civil society. As the ASEAN strives to maximize the potentials of digitalization, multi-stakeholder participation will be central to ensure successful implementation of programs and policies, and inclusive and sustainable benefits for all. While balancing the objectives of various stakeholders and actors is definitely a challenge, engaging and involving them in planning and policymaking will be a significant step in drawing their support and commitment towards a shared goal.

1. Producers and technology users (e.g., farmers, fisherfolks, other producers)

Technology users can help support the implementation of the Guidelines by:

- Actively participating in capacity building programs and trainings of the government and other stakeholders to increase their technological knowledge and improve their skills
- Accumulating enough knowledge to become a farmer-trainer, and eventually sharing personal experiences and lessons with other producers in the community.
- Building and organizing a network of technology users that can collectively identify and push for the sector's needs through a strong representation.
- Taking part in cross-sectoral consultation meetings and engaging stakeholders to ensure that their rights are upheld, and their voice and needs in important issues are highly considered and taken into account.
- Collaborating with stakeholder partners to implement programs and processes involving digital technology and maximizing the tools and new learning provided to them.

2. Financial and lending institutions

Financial and lending institutions can help support implementation of the Guidelines by:

- Providing easier access to affordable loans, insurance and capital, as well as assistance to credit transactions of producers, further extending financing to other actors in the value chain.
- Conducting financial management and literacy training programs in order to ensure proper accounting and optimization of loans, thereby lowering instances of loan default.
- Promoting the use of available digital financial tools and online payment services through information dissemination and trainings to a wider audience, bearing in mind the challenges experienced by smallholders and marginalized sectors.
- Providing financial advisory services and programs customized to address the needs of producers, cooperatives, and other agribusinesses.
- Exploring partnerships with other stakeholders in the private sector, civil society, and government agencies to reach producers and users even in remote and rural areas.
- Advocating for the improvement of government digital finance infrastructure and policies through regular dialogue with decisionmakers and offering support and resources to better serve the general public.
- Utilizing banking value chains and leveraging on the Guidelines to address the challenges of financial inclusivity in the ASEAN region.

3. Agribusiness enterprises and key players in the agri-tech industry

Agribusiness enterprises and key agri-tech industry players can help support the implementation of the Guidelines by:

- Considering how the Guidelines can become part of their business processes and industry practices.
- Investing in digital technologies and solutions to improve and positively transform trading relationships between producers and businesses.
- Organizing management workshops and skills training on the use of digital technologies and machineries.
- Assisting in linking producers to the market and promoting fair and just prices.
- Building partnerships with smallholders along the supply chain as a way to protect farmers from production and market risks.

- Putting in place mechanisms that will allow producers to learn more about entrepreneurship that can encourage them to be 'agripreneurs'.
- Providing constant guidance and mentorship, as well as timely advice for producers or users of digital technologies.
- Encouraging open communication and information sharing between producers and businesses in order to guide producers with relevant market issues and insights.
- Cultivating trust among stakeholders through continuous dialogue and regular consultation.

4. Academe and research institutions

Research institutions and the academe can help support the implementation of the Guidelines by:

- Documenting experiences and capturing lessons learned in the field to promote evidence-based digital agricultural transformation.
- Strengthening academe-government-industry and cross-sectoral linkages, especially to guide policymakers, share knowledge and experiences supported by science and research, and identify opportunities to narrow the digital divide.
- Guaranteeing the quality, usability, and effectiveness of digital technologies through actual tests in the field.
- Addressing issues on scalability through consulting the private sector on the challenges encountered in scaling technologies, and the conduct of business-model assessments to look into the feasibility of scaling, technology adoption and profitability.
- Conducting extension services that allow producers to be equipped with knowledge on the various uses of digital technologies in modern agricultural production and in addressing issues of climate change and sustainability.
- Addressing barriers to and issues on digital technology adoption through educational strategies and campaigns with a simplified, familiar language for effective communication.
- Ensuring inclusive innovation and development by implementing researches and programs on digital technologies to better serve vulnerable and marginalized groups (i.e., smallholder farmers and fisherfolks, women and youth in agriculture)

- Regularly monitoring the FAS to determine the progress of implementation of digital technologies and identify issues for the improvement of processes and outcomes.
- Facilitate partnerships with other research institutions and technology transfer groups in order to guide producers and new users as they adopt new digital technologies.

5. Civil society

Civil society can help support the implementation of the Guidelines by:

- Leveraging on the details of the Guidelines to plan strategies, programs, and approaches on the digital transformation of the food and agricultural sector.
- Supporting the government in its thrust of creating and improving basic conditions (e.g., infrastructure, policy and program support) through complementary capacity building programs and extension training that improve enabling conditions for a digital transformation (e.g., knowledge of mobile and digital technologies, digital skills, agripreneurial abilities) for digital technology users.
- Providing technical assistance and training support for government extension workers to improve their management, organizational, and technical abilities and knowledge.
- Spearheading IEC campaigns on the utilization of digital technologies and its related advantages to users, and on sustainable production that can empower them to improve their income, competitiveness, and quality of life.
- Inviting multisector dialogues to discuss current pressing and emerging issues affecting producers and technology users, whether it be about digital technologies or concerning the food and agricultural sector as a whole.
- Building a network of stakeholders and engaging them to collectively pour in efforts and investment to develop and scale up digital solutions intended for agricultural workers.
- Pushing for policies and programs intended for marginalized and vulnerable producers to involve them and increase their participation in policymaking processes, and to empower them to advocate for their rights and the causes they believe in.

- Mobilizing donor agencies and partners to better utilize available resources that can encourage producers and technology users to adopt digital technologies and technological processes.

References

Alexander, Kim S, Garry Greenhalgh, Magnus Moglia, Manithaythip Thephavanh, Phonevilay Sinavong, Silva Larson, Tom Jovanovic, and Peter Case. 2020. "What Is Technology Adoption? Exploring the Agricultural Research Value Chain for Smallholder Farmers in Lao PDR." *Agriculture and Human Values* 37 (1): 17–32. https://doi.org/10.1007/s10460-019-09957-8.

ASEAN. 2015a. "2016-2025 Vision And Strategic Plan for ASEAN Cooperation in Food, Agriculture and Forestry." https://asean-crn.org/wp-content/uploads/2017/04/08Sept_Vision-and-SP-FAF-final.pdf.

———. 2015b. "ASEAN Economic Community Blueprint 2025." Jakarta. https://doi.org/10.1355/9789814414296-012.

———. 2016. "Master Plan on ASEAN Connectivity 2025." Jakarta. https://asean.org/storage/2016/09/Master-Plan-on-ASEAN-Connectivity-20251.pdf.

———. 2020. "ASEAN Integrated Food Security (AIFS) Framework and Strategic Plan of Action on Food Security in the ASEAN Region (SPA-FS) 2021-2025." https://asean.org/storage/2020/11/42-AIFS-Framework-SPAFS-Final-13-July-2020.pdf.

———. 2021. "Strategic Plan of Action on ASEAN Cooperation in Agricultural Training and Extension (2021-2025)." https://asean.org/storage/SPA-Agricultural-Training-Extension-2021-2025-Final.pdf.

Asvanund, Atip. 2016. "Thailand's Readiness for E-Agriculture Strategy from the Perspective of the ICT Industry." In *E-Agriculture Solutions Forum*. Nonthaburi, Thailandthai: Food and Agriculture Organization. http://www.fao.org/asiapacific/events/detail-events/en/c/1343/.

Basso, Bruno, and John Antle. 2020. "Digital Agriculture to Design Sustainable Agricultural Systems." *Nature Sustainability* 3 (4): 254–56. https://doi.org/10.1038/s41893-020-0510-0.

Berdegué, Julio, Tomás Rosada, and Anthony Bebbington. 2014. "The Rural Transformation." In , 463–78. https://doi.org/10.1093/acprof:oso/9780199671656.003.0028.

Charoen Pokphand Group. 2018. "The Future of Thai Agriculture." 2018. https://www.cpgroupglobal.com/News/nDetail/articleid/74.

Eckstein, David, Vera Künzel, Laura Schäfer, and Maik Winges. 2020. *Global Climate Rate Index 2020 Who Suffers Most from Extreme Weather Events ? Weather-Related Loss Events in 2018 and 1999 to 2018*.

Emergency Events Database (EM-DAT). http://emdat.be. Accessed July 2021.

Financial Services Authority (OJK) of Indonesia. 2017. "OJK Launches Food ACTION (Acceleration-Synergy-Financial Inclusion) Program to Promote Food Security." 2017. https://www.ojk.go.id/en/berita-dan-kegiatan/siaran-pers/Documents/Pages/OJK-Launches-Food-Action-(Acceleration-Synergy-Financial-Inclusion)-Program-to-Promote-Food-Security-/SIARAN PERS AKSI PANGAN OJK 24 Maret 2017-ENGLISH.pdf.

Food and Agriculture Organization of the United Nations (FAO). 2006. "Food Security Policy Brief." Vol. Policy Bri. Food and Agriculture Organization of the United Nations (FAO). http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf.

———. 2017. "National E-Agriculture Strategy." Rome.

http://www.fao.org/3/i8133e/i8133e.pdf.
Habibu, Sira. 2020. "Agriculture Ministry Banking on E-Commerce Platforms to Attract Youth into Farming." *The Star*, June 15, 2020. https://www.thestar.com.my/news/nation/2020/06/15/agriculture-ministry-banking-on-e-commerce-platforms-to-attract-youth-into-farming.
Huawei. 2020. "Shaping the New Normal with Intelligent Connectivity: Global Connectivity Index 2020." https://www.huawei.com/minisite/gci/assets/files/gci_2020_whitepaper_en.pdf?v=20201217v2.
Husain, Arif, Susanna Sandström, Friederike Greb, and Peter Agamile. 2020. "Economic and Food Security Implications of the COVID-19 Outbreak." https://reliefweb.int/report/world/economic-and-food-security-implications-covid-19-outbreak-update-focusing-domestic.
IICA, IDB and Microsoft. 2021. "Digital Literacy in Rural Areas: An Indispensable Condition to Bridge the Divide in Latin America and the Caribbean." San Jose. https://www.iica.int/en/press/events/digital-literacy-rural-areas-indispensable-condition-bridge-divide-latin-america-and.
International Food Policy Research Institute (IFPRI). n.d. "Food Systems." Accessed April 19, 2020. https://www.ifpri.org/topic/food-systems.
Luu, Tien, Dung Luu Tien, Nguyen Thi, and Kim Hiep. 2017. "The Revolution of Agriculture 4.0 and Sustainable Agriculture Development in Vietnam." In *Emerging Issues in Economics and Business in the Context of International Integratoin*. Hanoi: National Economics University Press.
McIntosh, Craig, and Caio Scuarcialupi Mansini. 2018. "The Use of Financial Technology in the Agriculture Sector." ADBI Working Paper 872. Tokyo. https://doi.org/10.1007/978-1-349-67278-3_116.
Mia, Ian Benedict, and Raymund Habaradas. 2020. "ASEAN ICT Developments: Current State, Challenges, and What They Mean for SMEs," March.
OECD. 2001. "Understanding the Digital Divide." Paris. https://doi.org/10.4135/9781529714395.n417.
———. 2019. *Digital Opportunities for Better Agricultural Policies*. https://doi.org/https://doi.org/https://doi.org/10.1787/571a0812-en.
Onishi, Tomoya, and Marimi Kishimoto. 2019. "Asia's Farms Embrace Tech Revolution as Workers Become Scarce," November 2019. https://asia.nikkei.com/Business/Technology/Asia-s-farms-embrace-tech-revolution-as-workers-become-scarce.
Pulhin, Juan M., Makoto Inoue, Rajib Shaw, Millicent Joyce Q. Pangilinan, and Ma Louiella Rose O. Catudio. 2020. "Climate Change and Disaster Risks in an Unsecured World." In *Climate Change, Disaster Risks, and Human Security. Asian Experience and Perspectives.*, edited by Juan M. Pulhin, Makoto Inoue, and Rajib Shaw. Springer Nature Singapore. https://doi.org/https://doi.org/10.1007/978-981-15-8852-5.
"Rural Rising Philippines." n.d.
Safari, Suhana, and Amira Ngusman. 2019. "An Overview of Developments and Prospects for E- Commerce Agrifood Products in Malaysia." *Agricultural Policy Articles*, no. January: 1–7. https://ap.fftc.org.tw/article/1032.
Sayruamyat, Suwanna, and Winai Nadee. 2020. "Acceptance and Readiness of Thai Farmers Toward Digital Technology." *Smart Innovation, Systems and Technologies* 165: 75–82. https://doi.org/10.1007/978-981-15-0077-0_8.
Singapore Food Agency. n.d. "Food Farms in Singapore." Accessed June 10, 2021. https://www.sfa.gov.sg/food-farming/food-farms.

Supporting Economic Transformation. 2020. "Fostering an Inclusive Digital Transformation in Cambodia." Phnom Penh. https://set.odi.org/wp-content/uploads/2020/06/Fostering-an-Inclusive-Digitalisation-Transformation-in-Cambodia-Final.pdf.
Torbick, Nathan, Diya Chowdhury, William Salas, and Jiaguo Qi. 2017. "Monitoring Rice Agriculture across Myanmar Using Time Series Sentinel-1 Assisted by Landsat-8 and PALSAR-2." *Remote Sensing* 9 (February): 119. https://doi.org/10.3390/rs9020119.
Trendov, Nikola M, Samuel Varas, and Meng Zeng. 2019. "Digital Technologies in Agriculture and Rural Areas." Rome. http://www.fao.org/3/ca4887en/ca4887en.pdf.
UNDP. 2019. "Singapore's Emerging AgriTech Ecosystem." 2019. https://sgtechcentre.undp.org/content/sgtechcentre/en/home/blogs/sg-agritech-ecosystem.html.
Uppsala Conflict Data Program. htt://ucdp.uu.se. Accessed July 2021.
World Bank Group. 2019. "Future of Food: Harnessing Digital Technologies to Improve Food Systems Outcome." Washington, DC.
World Bank Open Data. http://data.worldbank.org. Accessed May 2021.

Annex 1: Uses of technology in the FAS

TECHNOLOGY PURPOSE	CATEGORY	SUB-CATEGORY
Data collection technologies	Remote sensing	Satellite-mounted data acquisition/monitoring systems
		UAV / drone-mounted data acquisition / monitoring systems
		Manned aircraft data acquisition/monitoring systems
	In situ sensing	Water quantity meters
		Water quality sensors, air quality sensors
		In situ meteorological sensors
		In situ soil monitors
		In situ biodiversity, invasive species or pest monitors
		Crop monitors
		Livestock monitors
		Data from precision agricultural machinery
	Crowdsourcing data collection	'Serious games' for gathering agri-environmental data
		Citizen science
	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	Digital Elevation Modelling
		Land Use-Land Cover mapping
		Watershed modelling
		Soil mapping
		Landscape modelling
		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 (e.g., carcass grading software)
	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

TECHNOLOGY PURPOSE	CATEGORY	SUB-CATEGORY
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 platforms	Digital communication technologies	Digital data visualization technologies
		Social Media
		Web-based video conferencing
		Machine-assisted communication (e.g., chatbots, natural language generation algorithms)
	Online platforms - property rights, payments, services and markets	Online property rights and permits registries
		Online trading platforms
		Platform-based crowdfunding for agriculture and agri-ecosystem services
		Online payment platforms (for public programs)
		Service delivery platforms

Source: OECD (2019)

Annex 2: Concept Map of Key Points of Discussion and Results of Knowledge Sharing Workshops and Scoping Surveys

Annex 3: Selected statistics on food security, digital infrastructure, and the ASEAN economy

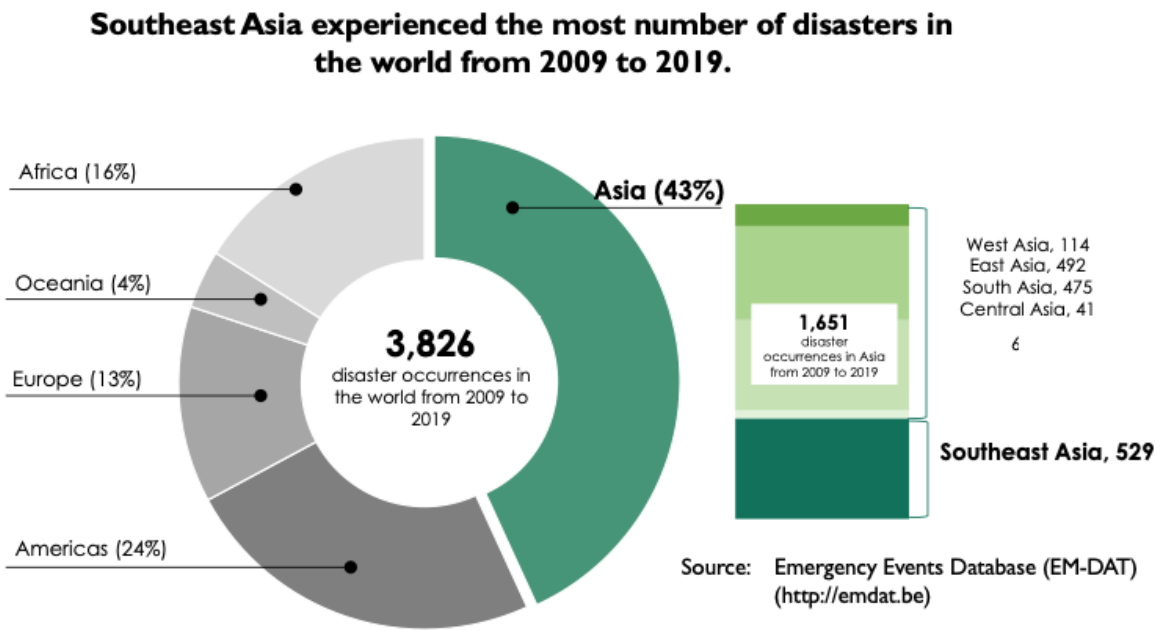

Figure 1. Disaster occurrences in Southeast Asia from 2009 to 2019.

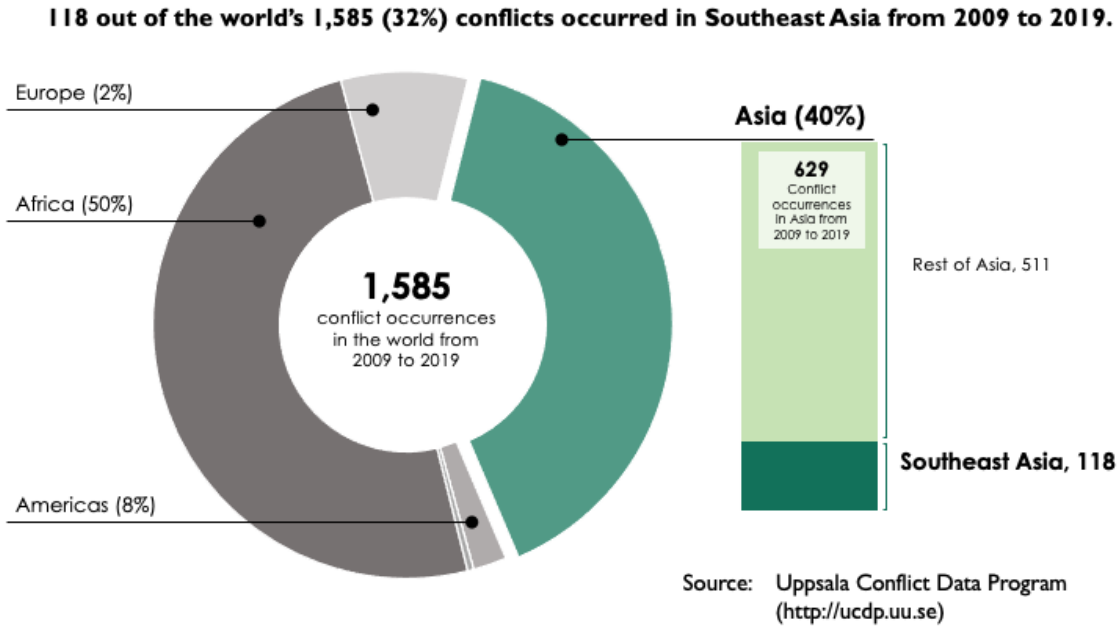

Figure 2. Conflict occurrences in Southeast Asia from 2009 to 2019.

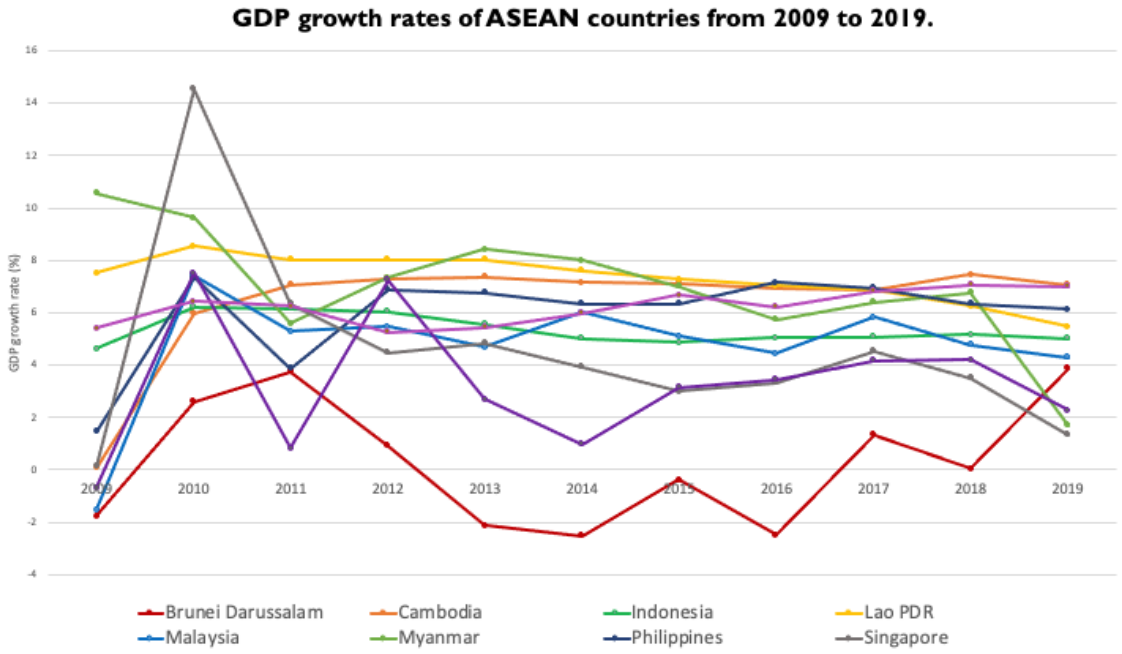

Figure 3. GDP growth rates of ASEAN countries from 2009 to 2019.
Source: World Bank (http://data.worldbank.org)

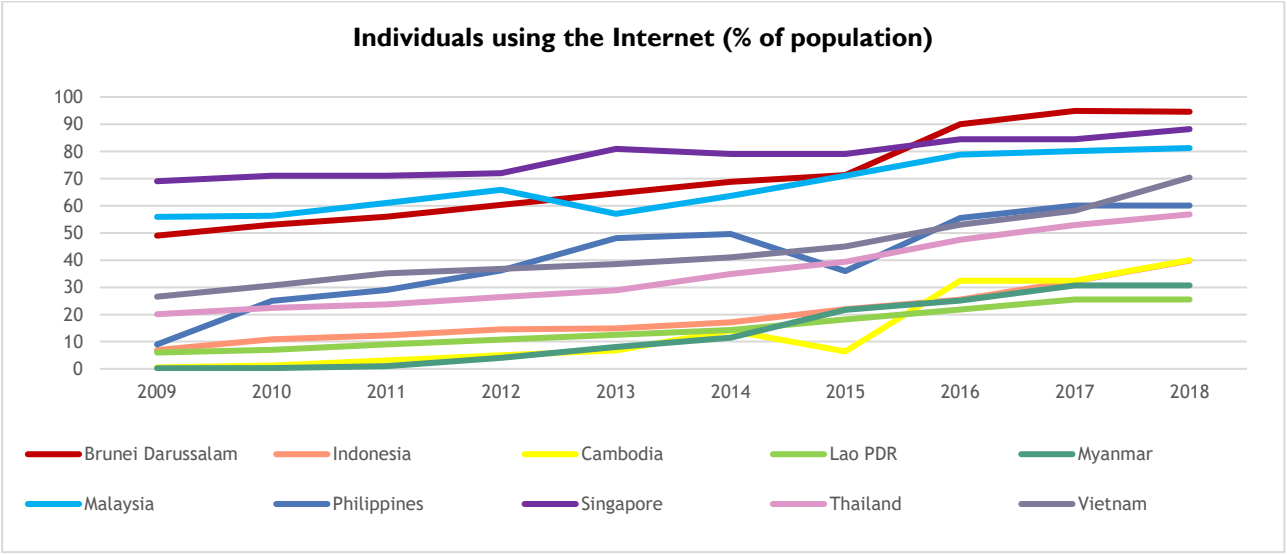

Figure 4. Individuals (percent of the population) using the internet from 2009-2018 in 10 ASEAN countries

Source: World Bank (http://data.worldbank.org)

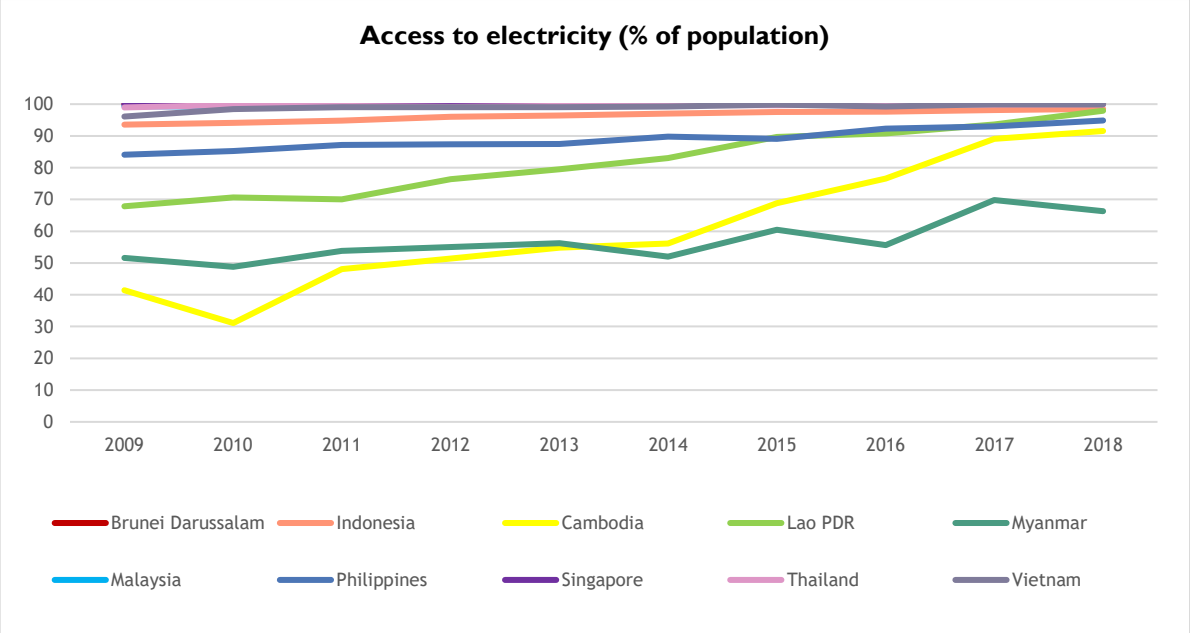

Figure 5. Percent of the population with access to electricity from 2009-2018 in 10 ASEAN countries

Source: World Bank (http://data.worldbank.org)

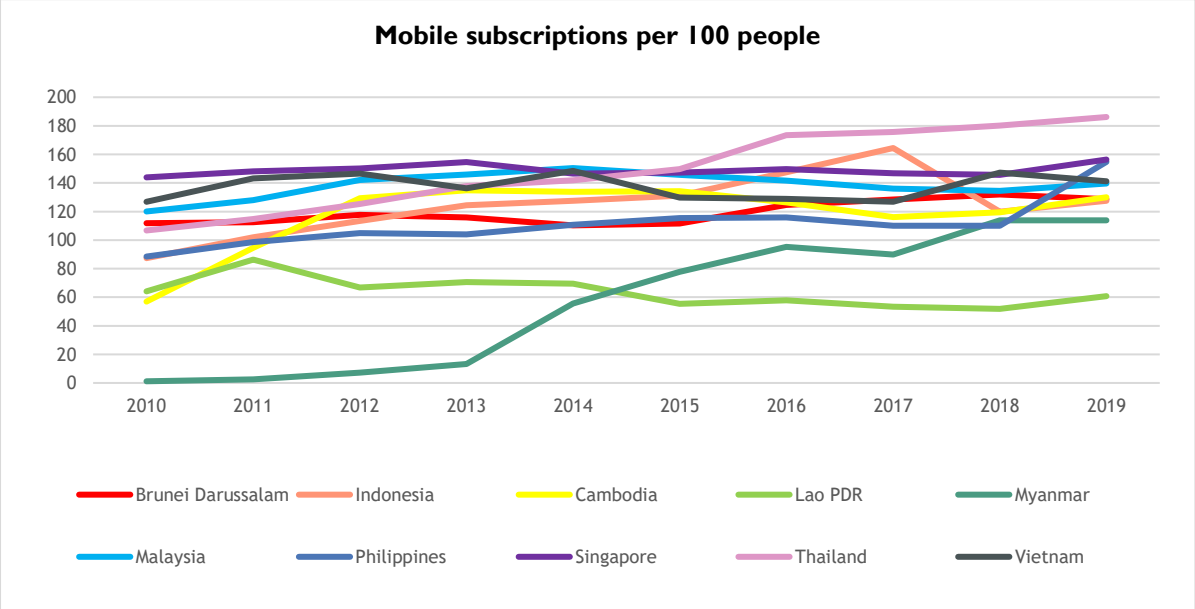

Figure 6. Number of mobile subscriptions per 100 people from 2010-2019 in 10 ASEAN countries.

Source: World Bank (http://data.worldbank.org)

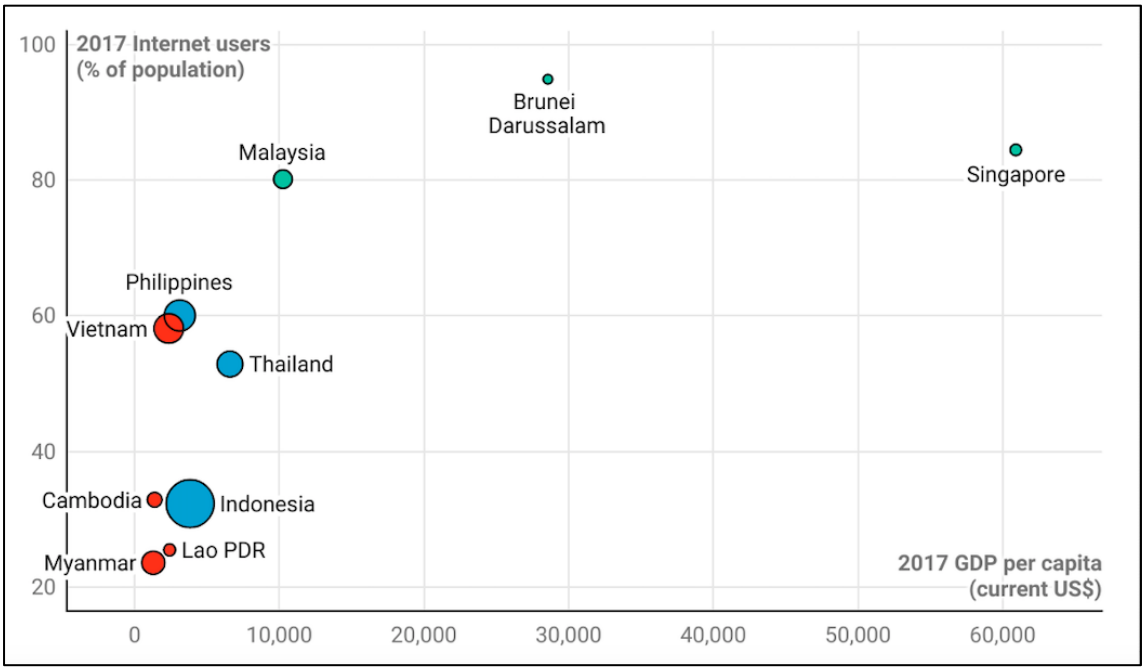

Figure 4. GDP vs. access to technology (internet access) of AMSs in 2017.

Source: World Bank (http://data.worldbank.org)

Note: The larger the circle, the bigger is the population.