Symposium

Accelerating the Digitalisation of the Agriculture and Food System in the ASEAN Region

Lessons Learned, Findings, and Recommendations

Edited by

Masanori Kozono
Siti Mustaqimatud Diyanah
Adli Hazmi

ERIA
Economic Research Institute
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Introduction

The agriculture and food system holds a key position in the economies of the Association of Southeast Asian Nations (ASEAN), serving as a primary source of employment and income for much of the region's population. Also importantly, it contributes significantly to ensuring national, regional, and global food security. However, the system faces numerous challenges, including increasing food demand for a growing population, rising malnutrition rates, adverse impacts of climate change, overexploitation of natural resources, ever-increasing carbon emissions, loss of biodiversity, and food loss and waste. To address these challenges, digital technologies have become essential, offering innovative solutions to boost productivity, optimise resources, improve market access, and support sustainable practices in the agriculture and food system.

Considering the importance of digitalisation in the agriculture and food system, ASEAN Guidelines on Promoting the Utilization of Digital Technologies for ASEAN Food and Agricultural Sector were developed amongst ASEAN Member States (AMS) and endorsed at the Forty-Third Meeting of ASEAN Ministers on Agriculture and Forestry (AMAF) in October 2021. Also, in the ASEAN Leaders' Declaration on Strengthening Food Security and Nutrition in Response to Crises, adopted at the ASEAN Summit in September 2023, ASEAN leaders agreed to accelerate digital transformation to increase productivity and resilience in the agriculture and food system, address challenges of climate change, reduce carbon emissions, and lessen food loss and waste. To realise these guidelines and commitments, concrete follow-up activities are required, and collaboration with ASEAN dialogue partners should be considered. For instance, the ASEAN-Japan MIDORI Cooperation Plan, which includes the application of advanced digital technologies and other innovations for enhancing resilient and sustainable agriculture, is emerging as a strong collaborative framework.

Collective efforts towards strengthening collaboration, knowledge sharing, and developing policy frameworks are essential to fully harness digitalisation for sustainable agricultural development in the region. The Economic Research Institute for ASEAN and East Asia (ERIA), together with the ASEAN Secretariat; Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan; and Ministry of Agriculture and Rural Development (MARD) of Viet Nam co-organised the ASEAN-Japan Symposium on Accelerating the Digitalisation in Agriculture and Food System to Promote Sustainable Agricultural Development in the ASEAN Region. It was held in Vung Tau, Viet Nam from 30 September to 1 October 2024.

The symposium was attended by government officials from AMS, Timor-Leste, and Japan, as well as representatives from businesses, academia, and international organisations. Through knowledge sharing and various discussions, the symposium worked to enhance awareness of digitalisation's role in sustainable agriculture within ASEAN, strengthen collaboration and networking amongst stakeholders to foster partnerships and knowledge sharing, identify

regulatory support for digital technology adoption, establish a platform to showcase innovative digital solutions and success stories, and create a common understanding of the necessity of an action plan to accelerate digital transformation in agriculture. The programme of the symposium is shown in Annex 1.

This report compiles the valuable information gleaned from the speeches, presentations, and discussions in the symposium (Chapter 1), and proposes some recommendations for future activities based on the obtained information (Chapter 2).

Finally, please note that the structure, interpretation, and analysis of the content from each presentation and discussion are solely the responsibility of ERIA and do not necessarily reflect the views or interventions of the presenters.

Chapter 1
Information Obtained from the Symposium

1.1. Views of Symposium Organisers

Representatives from the co-organisers of the symposium delivered remarks in the opening session. Key information on the use of digital technologies and innovation in the agriculture and food system was shared.

Tô Việt Châu, Deputy Director General, MARD, Government of Viet Nam

The transformative impact of digital technologies on agriculture could boost agriculture productivity while reducing negative environmental effects. In addition, the digital marketplaces that link farmers directly with consumers offer a pathway towards a resilient, efficient, and sustainable agriculture and food system.

MARD of Viet Nam issued Decision No. 2151/QD-BNN-VP in 2022 to support the Digital Transformation Plan for Agriculture and Rural Development (2022–2025) that focuses on building a digital agricultural ecosystem, transforming agricultural production into a broader agricultural economy. The plan serves as a roadmap for the digitalisation of agriculture with a vision towards 2030, providing a framework for future implementation and annual planning.

Exploring key areas such as digital platforms and market access, policy frameworks and regulatory measures, capacity building and knowledge transfer, public–private partnerships (PPPs) and investment opportunities, sustainable practices and climate resilience, and cross-border collaboration, including sharing information amongst AMS could help promote agricultural digitalisation and address the regional challenges.

Hideyuki Morii, Director and Senior Negotiator, Bilateral Affairs Division, Export and International Affairs Bureau, MAFF, Government of Japan

There are several important points to be made about food security. First, it is the government's responsibility to feed people in the country. Second, no country can achieve complete self-sufficiency in food or agricultural inputs, necessitating imports to complement domestic production. Therefore, cooperation is an important action for food security.

The recent COVID-19 pandemic and geopolitical issues have provided several lessons; for example, importing food and agricultural inputs is not always possible as desired. At the same

time, climate change is also a threat. Therefore, there is a need to make domestic agriculture and food systems sustainable by mitigating and adopting to climate change through various innovations.

Japan and AMS are located in the same Asia-monsoon region and are characterised by high temperatures and humidity, rice paddy-based agriculture, and a high percentage of small and medium-scale farmers. This suggests that many of Japan's new technologies can be utilised in AMS. With this in mind, the ASEAN-Japan MIDORI Cooperation Plan was adopted at the First ASEAN-Japan Ministers of Agriculture and Forestry Meeting in October 2023.

Masanori Kozono, Senior Policy Fellow, ERIA

Digital technologies have emerged in recent years that offer critical and innovative solutions for sustainable agricultural development through enhancing productivity, optimising resource allocation, and improving market access. Several successful cases of digital technologies in the agriculture and food system of the region can be observed, such as precision agriculture, farming advisory services, and agriculture trading through a digital marketplace. However, there are still limitations in some AMS. A 2023 ERIA study showed that the dissemination of digital agriculture in the ASEAN region remains limited, and there is a noticeable disparity amongst AMS. Further efforts of governments and other stakeholders are needed to enhance policy instruments and initiatives, effective and useful financial schemes, close collaboration between the public and private sectors, and cooperation with ASEAN partners.

In addition, more practical policy documents should be developed in the near future, such as an ASEAN regional action plan for accelerating digitalisation in agriculture, which would be follow-ups to the existing ASEAN Guidelines on Promoting the Utilisation of Digital Technologies for ASEAN Food and Agricultural Sector.

1.2. Keynote Presentations

Experts on food security and digital agriculture, who were invited as resource persons, shared their views on the application of digital technology to the agriculture and food system from a global and regional point of view.

Keynote Presentation 1

Interventions to increase digitalisation in food systems. Professor Paul Teng from the S. Rajaratnam School of International Studies, Nanyang Technological University, Singapore explained that in the digital technology era, the agricultural sector is being significantly impacted

by advancements in technology. Innovations such as drones, sensors, and the internet of things (IoT) have enhanced agricultural practices, promoting greater effectiveness and precision.

Macro and micro view on agricultural practices. Agriculture, food production, and environmental issues have grown more volatile in recent years, when solving one problem often sparks others. Thus, agricultural technology should prioritise efficacy (i.e. targeting key issues) and efficiency (i.e. using minimal resources). On a practical level, digital technology aims to increase output with fewer resources, following the 4Rs – right input, right rate, right place, and right time.

Precision agriculture using digital technology. Precision agriculture must incorporate management concepts by employing a management information system (MIS) approach encompassing observation, measurement, and response or intervention.[1] This approach ensures that data-driven decisions are made to optimise agricultural practices and to enhance overall productivity. Some countries have already integrated all of these functions into single devices. For example, smart drones can survey, analyse, and intervene simultaneously. This illustrates the limitless potential of innovation when applying digital technologies in agriculture.

Six policy recommendations. Recommendations to improve the use of digital technologies are:

1. Focus on crops with higher potential to adopt digital technologies like rice or plantation crops (e.g. palm oil).

2. Focus on a concerted approach, so PPPs are essential; the private sector typically develops most digital technologies, while the public sector creates an enabling environment for their implementation.

3. Encourage AMS to explore combined online-offline modes of delivering digital application through agricultural extension services.

4. Develop the ASEAN Platform for Cross-Boundary E-commerce in Agriculture.

5. Integrate digital traceability requirements into the ASEAN Food Safety Regulatory Framework.

6. Launch targeted information campaigns to raise awareness about the importance of e-commerce services in the agricultural sector, aimed at consumers and farmers.

In adopting the six recommendations, a bottom-up approach is essential that is supported by government backing, private sector involvement, local capacity building, and adequate financing. This approach aims to address challenges in agricultural technology adoption and to enhance precision in agriculture.

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[1] Blackie, M.J. and J.B. Dent (1979), *Information Systems for Agriculture,* London: Applied Science Publishers.

Keynote Presentation 2: Digitalisation for Sustainable Agriculture in ASEAN

Regional strategy and policy pathways. Venkatachalam Anbumozhi, Senior Research Fellow for Innovation, ERIA, shared his insights on digitalisation of agriculture practices for sustainability within ASEAN agriculture. The *ASEAN Guidelines on Promoting the Utilisation of Digital Technologies for the ASEAN Food and Agriculture Sector* provides a framework and mechanism to enhance equitable, sustainable, and inclusive economic development as well as to strengthen regional partnerships for food resilience. By implementing these guidelines, agricultural practices can effectively leverage digital technology to enhance sustainability and food resilience while promoting the inclusion of youth, women, and other marginalised groups, which is essential for the future of agriculture.

Key components of the digital transformation in agriculture. For digital transformation to succeed, it is essential to recognise farmers as entrepreneurs in the economic systems. Therefore, understanding the three key elements of digitalisation in agriculture is crucial. The first element, instrumentation, enhances productivity through technologies such as sensors and satellites. The second, integration, uses digital tools to streamline agricultural operations. Finally, intelligence enables farmers to analyse and to integrate supply and market data, improving decision-making in agricultural trade. By combining these elements, agriculture systems can achieve more efficient production, green innovation, and greater social inclusion.

Evolving digital technology ecosystem landscape in ASEAN. Based on a study conducted by ERIA, three key clusters of activities are crucial to the successful adoption of technology that contributes to ensuring the sustainability of agricultural practices in the region:

1. Production. Advanced digital technology plays a crucial role in data gathering, analysis, and automation. The use of drones, satellites, remote sensing, and ground sensors is essential for collecting vital information on soil quality, crop health, and environmental factors. In livestock farming, smart-breeding systems enhance the monitoring of animal health, ensuring improved productivity and efficiency.

2. Financial access in the supply chain. Digital financial access connects important actors along the entire agricultural value chain. Therefore, access to finance, including digital payment methods such as e-commerce platforms, is essential at this stage, as it enables farmers to make digital payments for agricultural inputs like seeds, fertilisers, and equipment more easily. Additionally, these digital platforms facilitate direct transactions between farmers and consumers.

3. Traceability of products and services in agriculture sector. Traceability ensures that products can be tracked from the farm to the consumer, including the origin of the products, adherence to food safety standards, and monitoring of production processes and chemicals. By providing this transparency, digital technologies empower consumers to make informed choices about their purchases while supporting compliance with safety regulations,

ultimately building trust in the agricultural supply chain from production to the wholesale, retail, and consumer levels.

Costs of digitalisation of farming systems. The cost of digital transformation is substantial. Financing is a crucial element in the digitalisation of farming systems, as adopting new technologies often incurs significant costs. Therefore, public-private partnership is essential to address this challenge. In this context, the transition to digital agriculture can be divided into four stages:

1. **Traditional agriculture (stage 1).** This stage relies primarily on manual labour and animal power, with little to no machinery. It requires minimal capital investment, as the tools and methods are basic and largely human-powered.

2. **Conventional agriculture (stage 2).** This stage introduces basic agricultural machinery while still relying significantly on manual labour. The use of machines increases efficiency but also leads to a moderate rise in investment costs compared to traditional methods.

3. **Smart farm systems (stage 3).** At this stage, sensor technologies are integrated into farming processes to optimise operations such as soil monitoring and irrigation. The capital requirements rise substantially, as these technologies enhance precision but come with higher upfront costs for equipment and infrastructure.

4. **Future smart farm systems (stage 4).** Fully automated systems are the focus, powered by advanced technologies like big data, IoT, artificial intelligence (AI), and deep learning. This stage demands the highest investment due to the sophisticated machinery, automated processes, and digital infrastructure involved.

Stakeholders need to make greater efforts in securing capital and financing to address the initial high costs of technology. A focus on financing smallholder farmers is also crucial, with policies designed to address their specific needs and to leverage digital services to reach remote areas, although improvements in digital infrastructure and credit-scoring capabilities are still needed. Furthermore, agricultural development banks are crucial in financing long-term investments, supported by commercial banks that provide working capital. In this context, digital tools are essential for integrating value chain actors, managing risks, and facilitating market information and partnerships.

Integrated policies for enabling digital transformation. Policies integration is a key enablers in addressing challenges like technology costs, availability of financing, and capacity building for digital adoption. The approach to digital transformation can be organised into three tiers of enablers:

1. **Tier 1.** These enablers focus on fundamental aspects such as improving the availability and accessibility of digital infrastructure, ensuring that physical infrastructure is in place, and institutional capacity is enhanced to support digital innovation.

2. Tier 2. These include more specific measures like enhancing access to agricultural data, creating legal and regulatory frameworks conducive to digital innovation, fostering competition in digital markets, supporting digital payment systems, promoting digital skills development, and encouraging digital entrepreneurship.

3. Tier 3. These enablers are centred around capacity-building for farmers, including improving their knowledge and skills, customising digital tools to meet their needs, reducing the costs associated with adopting digital technologies, and building trust in digital applications.

These policy enablers will help achieve sustainability and equity in agricultural practices across AMS. However, numerous innovations and experimentations are needed to successfully realise an inclusive digital transformation in agriculture sector.

Keynote Presentation 3: Digitalisation of Agricultural Trade

SPS electronic certification and remote audits for international food safety. Dr. Annelies Deuss from the Organisation for Economic Co-operation and Development (OECD) explained that Sanitary and Phytosanitary (SPS) measures ensure that food is safe for consumers and prevent the spread of pests or diseases among animals and plants. SPS measures apply both to domestically produced food or local animal and plant diseases, as well as to products coming from other countries. In the case of international trade, an SPS certificate is issued by the exporting country to attest that a consignment complies with the SPS regulations of the importing country. These SPS certificates used to be paper-based but several countries have started using electronic SPS certificates (or SPS e-certificates).

SPS e-certificates in agricultural trade: practices and implications. In July 2023, the OECD conducted a survey on the use of SPS e-certification. Responses from 26 countries show a significant increase in the share of trade for which the exchange of SPS e-certificates is possible, rising from 18.8% in 2018 to 32.7% in 2022, driven mostly by new agreements to exchange phytosanitary e-certificates. Modelling results indicate that the implementation of SPS e-certificates has positively impacted trade values between 2017 and 2022, with a 72% increase in the total trade value of plant products and a 48% rise in the total trade value of animal products. These findings indicate the significant role of SPS e-certificates in facilitating trade of agricultural products.

The role of remote audits in international food safety. Remote audits enabled international food trade to continue despite the severe COVID-19 pandemic disruptions. Based on case studies and a survey, the OECD examined the cost, benefits and effectiveness of remote audits. The analysis reveals that key benefits include lower travel expenses, reduced emissions footprints, more flexible use of time, and opportunities to train and involve more staff. There were nevertheless major drawbacks, including limitations to gather audit evidence, a heavy additional burden of preparation time, internet connectivity issues, and the lack of interpersonal engagement. In general, most stakeholders consider remote audits to be less effective than on-site audits, particularly for those of regulatory systems or for the physical auditing of establishments. This

report highlights the need to harmonise the terminology in this area of work, and to develop practical guidelines on how and when to conduct remote audits.

Keynote Presentation 4: ASEAN-Japan MIDORI Cooperation Plan focusing on Smart Agriculture and other Innovative Technologies

ASEAN and Japan's collaborative progress. Hideyuki Morii, director and senior negotiator, Bilateral Affairs Division, Export and International Affairs Bureau, MAFF, Government of Japan spoke about how the ASEAN-Japan MIDORI Cooperation Plan is a key partnership with the aim of transferring cutting-edge technologies from Japan to AMS, focussing on agricultural innovation. This cooperation seeks to enhance the adoption of advanced technologies to improve productivity, mitigate climate change, and build resilience in the region's agricultural sector. Several ongoing projects highlight the successful collaboration between AMS and Japan, demonstrating how innovative solutions are being adapted to local needs.

Innovative agricultural technologies for sustainability. Agricultural technology adoption in AMS is a key vision outlined in the plan; as an example, satellite-based soil diagnostics are being used to obtain accurate data on nutrient levels, pH, and carbon content in the soil. Moreover, a project in Thailand demonstrated a reduction in greenhouse gas (GHG) emissions while adapting to local agricultural needs. Another notable innovation is the automatic tractor steering system, leading to significant potential reductions in labour hours and lower costs for seedlings and fertiliser.

Climate-change mitigation and adaptation projects. The ASEAN-Japan MIDORI Cooperation Plan provides financial support to local farmers to implement the Joint Crediting Mechanism and encourages the use of using alternate wetting and drying (AWD) mechanisms. Currently, the Joint Crediting Mechanism is being established in the Philippines and Viet Nam, while the AWD project will begin in late 2024 in Cambodia, the Lao People's Democratic Republic (Lao PDR), and Viet Nam, which is expected to assist farmers in mitigating climate change and water use. Japan is also pushing forwards with developing low-cost agricultural production techniques and using biochar to reduce methane emissions.

Role of technology and partnerships in ASEAN's agricultural future. The ASEAN-Japan MIDORI Cooperation Plan represents a vital collaboration between AMS and Japan in advancing agricultural technology and sustainability. The initiative addresses the pressing challenges that the agricultural sector faces by harnessing cutting-edge technologies, smart agricultural practices, and strong PPPs.

Lessons learned from Japan's agricultural policy. The 2024 amendment of the Basic Law on Food, Agriculture, and Rural Areas represents a key turning point in Japan's approach due to its four core policy directions – food security, an environmentally sustainable food system, sustainable agricultural development, and rural development. These guiding principles have led to significant legislative changes in addressing modern agriculture's challenges. As ASEAN looks to the future, the lessons learned from Japan's policy experiences and the successful

implementation of innovative technologies will be crucial in building a resilient, sustainable agricultural system that can adapt to climate change and ensure food security for the region.

1.3. Sharing Experieces on Digital Technology Utilisation: The Business Perspective

In the panel discussion session, seven key presenters shared their experiences in integrating digital technology into agricultural practices, focussing on soil analysis, drone technology, market empowerment, and PPPs. The panellists were representatives from Olam Agri and At Source, Grow Asia, Japan Association for International Collaboration of Agriculture and Forestry (JAICAF), Sagri Co., Ltd, Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD), TCS AgroTech Company, and Niigata University. The moderator was Professor Paul Teng. The session focussed on the impact of technology adoption in agriculture, summarising key takeaways for future digital agriculture implementation in ASEAN.

Key Takeaways for Future Digital Agriculture in ASEAN

Soil analytic technology. In crop management, soil analysis provides farmers with essential information about carbon content, nutrients, and pH levels. These data enable farmers to make informed decisions regarding crop management. Sagri Co., Ltd highlighted that satellite-based soil analytic technology can deliver real-time data to farmers and significantly enhance efficiency. This technology is 10 times cheaper and faster than traditional analysis methods. It empowers farmers to implement soil management practices more effectively on a larger scale, ultimately improving crop health, boosting yields, and reducing costs.

Utilisation of digital technology for precision agriculture. Another crucial factor in agricultural practices is crop treatment. The adoption of digital technology, particularly drones, has surged. Drones assist farmers with crop monitoring and spraying fertilisers and pesticides. By integrating GPS and image-processing technologies, drones can accurately map fields, even in challenging, hilly terrains where crops, such as durian, are cultivated. The precision-farming approach enables farmers to manage resources more effectively, reduce input costs, and minimise environmental impact. In Thailand, TCS AgroTech, with over 40,000 drones in operation, exemplifies the efficiency of drone-assisted fertilisation. Panellists concurred that technology is increasingly vital for advancing precise and sustainable agricultural practices.

Digital solutions for climate-smart agriculture and carbon management. Disaster management is closely linked to early-warning systems, water management, carbon management, and reducing carbon emissions. The use of technology to mitigate climate change and to manage carbon was discussed as a key issue. In this regard, JAICAF established an information and communications technology (ICT) water management network in Viet Nam, supported by the Japan-ASEAN Integration Fund (JAIF). It installed advanced irrigation systems equipped with sensors that monitor water levels and environmental conditions, providing real-time data to enhance irrigation efficiency and to contribute to the sustainable management of water

resources, particularly in rice production areas vulnerable to floods and drought. Moreover, the sensors and Thematic Mapper (TM) system are crucial during disasters, providing information on water levels that help suggest interventions. Sagri Co., Ltd is collaborating with local sugarcane farmers in Viet Nam to provide data that monitor and reduce carbon emissions, allowing farmers to participate in carbon credit markets. This project, which involves 4,000 farmers across 10,000 hectares, can empower smallholders to benefit financially from adopting more sustainable practices.

Use of digital technology in fisheries. IPSARD developed a fishery monitoring system to track and to manage the activities of fishing vessels in Viet Nam. Viet Nam's experience with the monitoring system, which integrates satellite and GPS technology, ensures the legal, safe, and sustainable exploitation of marine resources while also combating illegal, unreported, and unregulated fishing.

Smart village model for digital transformation. The smart village concept offers an opportunity for success in digital transformation. IPSARD emphasised that a smart village consists of five core elements: smart institution, smart resources, smart infrastructure, smart services, and smart production business. Smart institution focusses on governance and regulations to create a secure, well-managed environment. Smart resources include skilled officials, finance, and digital literacy amongst residents. Smart infrastructure provides essentials like transport, water, and ICT connectivity. Smart services cover education, health care, and tourism, enhancing residents' quality of life. Finally, smart production business supports local industries through efficient production and distribution, fostering a self-sustaining rural economy. The concept of a smart village hinges on a holistic integration of resources, infrastructure, and services supported by effective institutional frameworks.

Fostering PPPs. Digital technology as a catalyst in agriculture depends significantly on strong PPPs to foster a dynamic startup ecosystem. These collaborations are crucial for driving innovation, scaling solutions, and making digital tools accessible to farmers on a large scale. Sagri Co., Ltd's partnership with 4,000 sugarcane farmers in Viet Nam shows the vital role of private sector initiatives in improving agricultural productivity and sustainability. Sagri Co., Ltd provides farmers with advanced satellite-based soil analytics and carbon-credit generation projects, delivering both technological and financial benefits. Similarly, JAICAF's irrigation project in Viet Nam which was supported by JAIF highlights the potential of technology transfer through collaboration. Additionally, IPSARD pointed to MARD of Viet Nam and the United Nations Development Programme's 2023 project in Binh Thuan, which enables dragon fruit farms to reduce carbon emissions by 68% and to integrate solar power systems, showcasing how partnerships facilitate sustainable technology adoption. This example underscores the importance of aligning the visions of governments and the private sector to launch innovations that support agricultural sustainability. While the public sector offers regulatory support and infrastructure, the private sector contributes the technological expertise and resources needed to scale these innovations. By working together, these partnerships can accelerate the adoption of smart agriculture technologies, benefiting both the environment and rural economies.

Fostering innovation through knowledge sharing. PPPs are crucial for fostering innovation in agriculture by facilitating knowledge sharing and capacity building. An example of this is Grow Asia's digital learning series, which serves as a platform for stakeholders to exchange insights on developing and scaling digital solutions for smallholder farmers by sharing best practices and successful case studies. Knowledge sharing and technology transfer are becoming the keystones for digital agriculture. By partnering with academia, private companies can access cutting-edge research, leading to innovative technologies that address challenges, promote climate-smart practices, and enhance sustainable productivity, minimising environmental impacts. In addition, training and capacity building are critical to ensure successful implementation and to foster sustained innovation in the field.

Market enhancement using digital platforms. Another significant issue in agricultural practice is finding avenues to sell products. The enhancement of market platforms, particularly e-commerce, is crucial for sustainable agriculture through trade. In this context, digital platforms such as Olam Market and SENDO facilitate consumer-to-consumer and business-to-consumer trade activities. Furthermore, MARD of Viet Nam, in collaboration with TikTok, is providing a unique opportunity for learning about agriculture through videos while enabling farmers to sell their products directly.

Open Discussion

Ensuring the affordability of digital agriculture. The high cost of technology is a major barrier to the adoption of digital agriculture. Panellists emphasised two key factors that are critical in addressing this issue. First is the affordability of the technology. Farmers in ASEAN need solutions that are not only affordable but also ensure that the benefits of using the technology outweigh the costs. Many farmers seek short-term gains, while the adoption of digital technology often provides long-term advantages. It takes 5 to 10 years to decrease the cost of technology and to make it more accessible. The second key factor is simplicity. The complexity of many digital tools often creates barriers to adoption, as farmers are forced to navigate complicated systems. To address this, the technology must be designed to be easily understandable and usable by farmers. Many farmers still rely on traditional farming methods because the available technologies require extra effort and knowledge to implement effectively.

Leveraging knowledge transfer for the future. The knowledge transfer involved in technology adoption is a crucial area. The ageing of the farming population impacts the adoption of new technologies. Thus, it is important to involve youth in the knowledge transfer process to ensure the future of agricultural technology adoption. By engaging younger farmers, technology can be better integrated into farming practices, helping modernise agriculture for the long term.

Utilising drones in pesticide practices. The overuse of fertilisers and pesticides can harm the environment. The panellists agreed that drone technology offers a solution by enabling precise application of fertilisers, preventing overdosing. This approach protects the environment, saves time, and reduces costs for farmers, making the technology both environmentally and economically beneficial.

Policy collaboration for digital technology adoption. The adoption of technology necessitates cross-border collaboration to address various aspects. Enablers play a crucial role in driving the adoption of digital technology. The participants proposed the establishment of a regional platform to share best practices and experiences in digitalisation. A review of regional policies is essential to identify opportunities and discrepancies, with the aim of establishing a common perspective on digital agriculture policy. Policies related to financing and investment must also be taken into account for technology development. Many small companies in Asia struggle to expand their technologies due to a lack of funding. Consequently, collaboration amongst governments, startups, investors, and enterprises is vital to fostering technological growth.

1.4. Digital Technology Adoption in ASEAN: The Government View

Representatives from AMS governments shared their experiences with digital technology adoption, while Japan provided valuable insights into its collaborative projects on digital transformation within the ASEAN region. This exchange highlighted the collective efforts and challenges faced by the region in integrating digital technologies in the agricultural sector (Annex 2).

Best Practices to Accelerate Digital Agriculture Transformation

Exploring leading digital initiatives across AMS. The symposium underscores the extensive adoption of technology in agricultural practices in AMS. Key innovations such as IoT, drone technology, and the rise of e-commerce are transforming the sector, showcasing the region's commitment to modernising agriculture.

Utilisation of IoT in AMS. The adoption of IoT in AMS is one of the most widely implemented initiatives, featuring various innovations to improve efficiency and to promote sustainability in agricultural practices. In Brunei Darussalam, IoT technologies are used to monitor crop health through weather stations, enabling farmers to adjust their practices based on current conditions. Additionally, sensors that measure soil properties, pH levels, and fertiliser application are utilised to optimise nutrient usage and to reduce waste. Indonesia's focus on developing SISCrop 2.0 to support smart farming initiatives highlights IoT applications for obtaining real-time data to monitor crop health and to predict yields, particularly for rice. Furthermore, in Malaysia, the adoption of IoT centres on sensor systems that incorporate global navigation satellite systems for land levelling and variable rate fertiliser technology to analyse nutrient requirements. Malaysia also uses IoT to monitor paddy fields and to gather real-time data on yield development. Thailand utilises IoT through a decision support system that uses sensors to facilitate data-driven management of pests, soil conditions, and water resources. Viet Nam's adoption of IoT is exemplified by its smart village model and ICT water management initiatives. All of those initiatives showcase a comprehensive approach to integrating technology into sustainable agricultural practices across the region.

Drone technology adoption in AMS. Drone technology has emerged as a pivotal tool across ASEAN for enhancing agricultural practices, primarily in precision spraying, crop monitoring, and data collection. Each AMS tailors the deployment of drones to meet its specific agricultural needs, aiming to increase productivity and effectiveness, reduce waste, and promote sustainable farming. In Brunei Darussalam, drones are used for the precise application of fertilisers and pesticides, monitor crop health, and detect pests like planthoppers. Indonesia has integrated drones into its Smart Farming 4.0 initiative to monitor crop health and to spray rice paddies. Equipped with sensors, these drones provide high-resolution data that support data-driven decision-making. In Malaysia, drones are utilised for yield monitoring and precision fertilisation in paddy fields, using GPS technology to deliver real-time data on crop growth and pest presence, thereby optimising resource use. Thailand uses drones for fertiliser and pesticide application to high-value crops, with GPS and image-processing technologies enabling accurate mapping even in difficult terrains. Furthermore, Japan's support has significantly advanced drone adoption across the region, providing expertise in navigation, imaging, and precision application. This collaboration enhances productivity and sustainability, making drones indispensable in the modernisation of agriculture in ASEAN.

Enhancing ICT water management for climate resilience. ICT for water management has become essential for optimising irrigation, conserving water, and promoting sustainable agricultural practices in several AMS, especially in areas with limited or high-water resources. In Viet Nam, an ICT network specifically designed for rice-farming areas prone to flooding and drought incorporates sensors that monitor water levels and environmental conditions in real time, enabling farmers to manage irrigation systems and providing alerts during extreme weather events, such as typhoons, to protect crops. Thailand uses smart irrigation systems to ensure precision in fruit farming. These systems automatically adjust water distribution based on soil moisture data, optimising water use according to crop requirements. The Lao PDR integrates ICT into the Lao Climate Services for Agriculture (LaCSA), which offers real-time weather updates and irrigation recommendations, helping farmers anticipate their water needs while minimising waste and enhancing climate resilience. Cambodia has recently begun adopting ICT-based water management systems in its rice paddies, using AWD techniques supported by sensors that monitor soil moisture and water levels. This innovative approach reduces water usage and carbon emissions, thereby preserving soil health. Japan has significantly contributed to the development of ICT water management systems in these AMS through training and the provision of low-cost sensor technology. These systems minimise water waste and enhance the resilience of agricultural practices to climate variability, aligning with sustainable water management strategies throughout ASEAN.

E-commerce transformation in ASEAN agriculture. E-commerce platforms are significantly transforming agriculture across ASEAN by facilitating direct connections between farmers and consumers, thus enhancing market access, particularly in rural areas. In Viet Nam, the SENDO platform enables both consumer-to-consumer and business-to-consumer transactions, allowing farmers to sell their produce directly to consumers, ensuring fairer prices and broader market reach. Similarly, the Philippines has established e-Kadiwa, a government-supported platform

that aids in distributing agricultural products and managing prices, especially during supply-chain disruptions, thereby improving income stability for farmers. Cambodia's CAMAgriMarket offers an online marketplace that provides farmers with insights into current market trends and prices. In Indonesia, TaniHub connects farmers with urban markets, enhancing their ability to sell fresh produce and processed goods. Collectively, these e-commerce initiatives are streamlining supply chains, increasing income opportunities, and contributing to more resilient and sustainable agricultural practices throughout the region.

Challenges in Accelerating Digital Agriculture Transformation

Addressing challenges in adopting digital agriculture. Technology adoption in the agricultural sector has proven to have a limitless potential to enhance precision and to help farmers create an environment that can achieve effective agriculture practices for sustainability. However, there are several challenges facing AMS and Japan:

1. High cost of technology. In the discussion amongst country representatives, the biggest challenge noted in digital transformation is the high cost of technology. Many farmers, especially small-scale farmers, cannot afford advanced technologies. Farmers often weigh the benefits against the costs when considering digital technology purchases, and farmers are inclined to maintain traditional farming practices when the costs outweigh the benefits.

2. Inadequate infrastructure. Inadequate digital infrastructure, such as limited electricity and internet access, hampers the adoption of digital agriculture, particularly in remote and rural areas. Connectivity challenges limit the effectiveness of technologies like real-time data and monitoring systems. Infrastructure development is slowed by high investment costs, varying geographic conditions, and the impacts of climate change, which lead to more frequent disasters. There is a significant gap amongst AMS in terms of digital technology adoption due to underdeveloped infrastructure in some countries.

3. Poor technical skills and digital literacy. Limited digital literacy of farmers, extension workers, and technical workers poses another considerable challenge. Many farmers find it difficult to operate digital technologies due to a lack of knowledge and understanding of their complexities. This issue is particularly pronounced in rural areas, where familiarity with advanced technology is often minimal. Moreover, an ageing farmer population adds more challenges to advancing digital literacy. This demographic affects the ability to engage with advanced technology. In contrast, younger farmers tend to adapt to digital technology more readily. Lack of knowledge and training for extension workers and technical workers hampers transfer knowledge process to farmers.

4. Regulatory and policy barriers. Despite many AMS having the same notion of adopting digital technology into agricultural practices, some countries are still limited by policy frameworks that support full-scale digital agriculture transformation. Coordination between stakeholders also influences the process of accelerating digitalisation in agriculture. Thailand is an example revealing that its political changes have affected digital transformation.

5. **Limited data availability and data security.** The above-mentioned challenges impact real-time data availability to support agricultural digitalisation. This condition is exacerbated by limited capability for data collection, inaccurate data management, vague data law, and cybersecurity issues.

Policy Instruments to Accelerate Digital Agriculture Transformation

Exploring policy frameworks to support digital agriculture in ASEAN. Several AMS have already laid the groundwork through comprehensive policy measures to integrate digital solutions within their agricultural sectors. Key policy areas include digital infrastructure development, regulatory frameworks, productivity and market access strategies, long-term digital transformation plans, and public-private collaboration.

Digitalisation and ICT infrastructure development. A key pillar of advancing digital agriculture in ASEAN is establishing a robust digital infrastructure. Through Law No. 16 of 2006 and the Minister of Agriculture Regulation No. 48 of 2020, Indonesia's policy framework actively promotes farmers' digital technology adoption, encouraging ICT integration into the agricultural sector. Similarly, the *Lao PDR's Agricultural Development Strategy to 2025 and Vision to 2030*, Malaysia's establishment of the Ministry of Digital and National Digital Department, the Philippines's National Information Network initiative, and Viet Nam's 13th National Congress commitment all underscore strong policy support for digital transformation. These policies represent significant strides towards equipping farmers with the digital tools and infrastructure needed to modernise agriculture throughout the region.

Legal and regulatory frameworks. A comprehensive legal and regulatory framework is essential for facilitating the digital transformation of agriculture across ASEAN. Indonesia's Law No. 16 of 2006 and Minister of Agriculture Regulation No. 48 of 2020 established a solid foundation for integrating digital technology into agricultural practices, promoting the use of ICT amongst farmers and ensuring data security through Law No. 19 of 2016 (ITE). Viet Nam's strategic direction from the National Committee on Digital Transformation and the 13th National Congress underscores the importance of digitising agricultural data management and fostering an environment conducive to digital innovation. In Thailand, the *National Economic and Social Development Plan 2023–2027* and *National Strategy (2018–2037)* support agricultural productivity and sustainability through digital initiatives. Meanwhile, Malaysia's *Public Sector Digitalization Strategic Plan 2021–2025* and the establishment of the Ministry of Digital and National Digital Department provide a clear policy framework for implementing digital solutions across the public sector, including agriculture. The Philippines's enhancement of the National Information Network reflects a commitment to private sector collaboration, facilitating innovation and investment in digital agriculture. Collectively, these frameworks serve as significant enablers of digital transformation, providing farmers across the region with the necessary legal support to adopt and to benefit from digital innovations in agriculture.

Productivity and market development. Policies focussed on productivity and market development serve as a crucial foundation for promoting sustainable agriculture. In Cambodia,

the deployment of commune agricultural officers at the local level aims to enhance farmers' productivity significantly. Concurrently, the government is committed to improving market accessibility and stabilising prices to ensure food security. In Thailand, the *National Economic and Social Development Plan 2023–2027* fosters sustainable growth within the agricultural sector, supporting the long-term viability of both farmers and consumers. Meanwhile, Viet Nam's Orientation of the National Congress 2024 underscores the importance of digitising the economy and enhancing digital management, leading to the creation of mobile apps that provide farmers with easier access to markets.

Long-term strategic planning for digital transformation. Strategic planning is essential for the long-term digital transformation of agriculture. Indonesia's *National Medium-Term Development Plan 2020–2024* outlines comprehensive strategies for agricultural digitalisation, providing a structured framework for progress. Similarly, Viet Nam's National Congress and the National Committee on Digital Transformation are establishing national priorities to steer sectoral digitisation. These long-term strategies underscore a commitment to continuous digital integration within agricultural value chains, facilitating broader sectoral development over time.

Public-private collaboration and investment facilitation. PPPs are essential for advancing digital agriculture, especially in developing and adopting new technologies. Indonesia's Minister of Agriculture Regulation No. 48 of 2020 promotes collaboration between the government and private entities to enhance agricultural productivity through digital solutions. In Myanmar, the government encourages private sector participation through its long-term ICT development policies to attract private sector involvement and to facilitate access to advanced tools and services that accelerate the digital transformation process. The Philippines fosters innovation in digital agriculture by inviting private sector investment and collaboration, reflected in various governmental initiatives that support the sector's growth. Similarly, Viet Nam supports PPPs through National Congress directives that support innovation in agriculture by leveraging private sector investment for modernisation efforts. Thailand's public-private collaboration under the *National Economic and Social Development Plan 2023–2027* is crucial to enhancing the agricultural sector's competitiveness and sustainability.

Open Discussion

Government collaboration with the private sector. Participants emphasised two key factors crucial to the success of digital transformation in agriculture: (i) collaboration between governments and the private sector and (ii) the development of effective policy frameworks. Many cutting-edge digital technologies in agriculture have been initiated and developed by private companies. For example, in Brunei Darussalam, the Agricultural Information Management System (AIMS) was developed by a private company (InnovAero). This company also provided drone services during a major brown planthopper outbreak, showcasing the role of private sector innovation in addressing agricultural challenges. Recognising the complexities involved in developing digital technology, participants suggested that governments should collaborate with private companies in terms of research funding as well as equipment and tool support. In Malaysia, the Malaysian Agricultural Research and Development Institute

has allocated USD70 million to 80 million over 5 years for research and development across various agencies and universities. In Thailand, the government has established a strategic fund focussed on key national strategies, including digital transformation. This fund encourages collaboration between various stakeholders, even across different ministries, promoting a coordinated approach to digital agriculture. In the discussion, the issue of affordability also emerged. This can be addressed through supportive governmental policies. For instance, Japan's Smart Agriculture Act provides low-interest funding through public banks to support the development and adoption of digital technologies in agriculture. This approach is helping make advanced technologies more accessible to farmers, fostering broader adoption and improving agricultural productivity.

Protecting cybersecurity. A major concern raised by participants was cybersecurity, particularly regarding the protection of sensitive data such as personal information. Many digital technologies in agriculture involve third-party developers or operators, and in several AMS, governments do not possess their own state-run servers. This lack of in-house infrastructure increases the vulnerability of sensitive data, making them susceptible to breaches. To address these challenges, implementing robust cybersecurity laws, trade regulations, and data limitation policies are essential actions. Such regulations should clearly outline which types of data can be shared and which must be protected, ensuring a secure framework for digital technology use. Despite these efforts, participants acknowledged that the fast-paced advancement of technology poses an ongoing cybersecurity threat, and while measures can be taken to mitigate risks, completely eradicating cybersecurity threats remains a significant challenge in the current digital era.

Application overload and e-commerce export compliance. Another key issue raised is the overwhelming number of apps available to farmers, leading to confusion and inefficiency. Both Viet Nam and Thailand pointed out that multiple stakeholders, including off-takers and governmental departments, frequently introduce different apps, creating overlap and inconsistencies, resulting in low adoption rates. Addressing this challenge requires clearer regulations, farmers' educational improvement, and stronger governmental support. In the future, services providers are expected to play a more significant role in agricultural technology, but difficulties in fostering trust and transparency between farmers and providers persist. To ensure compliance with the import regulations of destination countries, e-commerce platforms need to be integrated into national one-gate systems. Such systems help ensure that agricultural exports meet the standards and regulations of importing countries, ensuring smoother transactions and minimising trade disruptions.

1.5. Wrap Up and Way Forwards

At the end of the session, the ASEAN Secretariat concluded the discussions by highlighting three key aspects that must be addressed for successful technology adoption: efficiency, inclusivity, and effectiveness. To tackle challenges, stakeholders should work together to fully harness the benefits of digital technology. The cost challenges in digital transformation require multi-sectoral intervention and active engagement, with private sector involvement crucial to achieving inclusive and sustainable digital transformation across the region.

Collaboration will be a key mechanism for the future of digital technology adoption in agriculture. Two essential steps will ensure a successful digital transformation and address ongoing challenges:

1. Information sharing. The first step is to share the valuable insights gained during the symposium and to take full advantage of this knowledge. This will facilitate further exchanges, extending beyond ASEAN and including the private sector.

2. Development of a regional action programme. There is a need to explore the development of regional action programme, building on the existing ASEAN Guidelines on Promoting the Utilisation of Digital Technologies for ASEAN Food and Agricultural Sector and other initiatives.

The success of digital transformation relies on strong collaboration amongst stakeholders, ensuring inclusivity for all. A supportive policy framework is essential to enable stakeholders to contribute effectively to the implementation of digital technologies. Therefore, it is recommended that governments in AMS create an environment that enhances the use of digital technology and encourages broad collaboration across sectors.

Chapter 2
Recommendations for Future Actions

Through review and analysis of the information obtained from presentations and discussions at the symposium, the following actions must be considered for further promotion and acceleration of digitalisation of the ASEAN agriculture and food system.

Foster PPPs for funding and collaboration. PPPs are key to accelerating digital transformation within the food and agriculture sector, as the success of digital agricultural practices relies on active private sector involvement. By collaborating with private enterprises, governments can facilitate the adoption of digital technologies on a national scale in the ASEAN region. Startups, in particular, play a crucial role in technology adoption, often introducing innovative solutions that can have a greater impact. Thus, governments should actively engage with and collaborate with startups to ensure wider adoption of technology across the food and agriculture sector. In addition, issues such as the high cost of technology and its availability in rural areas, can be better addressed through the combined efforts of both the public and private sectors.

Encourage research and development for technology innovation. As the foremost challenge in digital transformation is the high cost of technology, there is a need to support, encourage, and empower governmental institutions, the private sector, and academia towards research and development. This would help produce and innovate technologies that are more affordable and applicable for farmers, particularly in rural areas.

Build capacity and provide training for technology adoption and knowledge transfer. Another significant challenge in digital transformation is farmers' ability to operate digital technologies. Therefore, capacity building, workshops, and training are essential to ensure that extension workers, technical staff, and farmers can understand and utilise digital technology in agricultural practices. Consequently, farmers will be better positioned to adopt advanced technologies for long-term benefits.

Develop more practical policies for technology adoption. Policy plays a vital role as an enabler of digital transformation; thus, establishing practical policies to support technology adoption is needed. These policies should encompass clear guidelines, regulations, a national plan, funding mechanisms, and implementation strategies to ensure effective and widespread integration of digital technologies in agriculture.

Ensure collective efforts in developing an action plan. Strong collaboration amongst stakeholders as well as enablers will boost the adoption of digital technologies. Establishing an enabling environment not only supports the adoption of digital technology but also encourages extensive collaboration across sectors.

Conduct field surveys to assess the actual condition. Field surveys provide valuable insights by assessing on-the-ground realities. Results could identify the challenges, needs, and possible solutions for each stakeholder to accelerate digital transformation in ASEAN. Studies will also help develop recommendations for future policies that are aligned with actual conditions.

ANNEX 1
Programme of the Symposium

Day 1, 30 September 2024

Time	Agenda	Resource Person
08:30–09:00	Welcome Remarks	**Tô Việt Châu** Deputy Director General, International Cooperation Department Ministry of Agriculture and Rural Development (MARD), Viet Nam
	Opening Remarks	**Hideyuki Morii** Director and Senior Negotiator, Bilateral Affairs Division, Export and International Affairs Bureau, Ministry of Agriculture, Forestry and Fisheries (MAFF), Japan **Masanori Kozono** Senior Policy Fellow ERIA
09:00–09:10	Meeting Overview	ASEAN Secretariat
09:10–09:15	Photo Session	
09:15–09:30	Digitalisation of Agricultural Trade	**Annelies Deuss** Senior Agricultural Policy Analyst, Trade and Agriculture Directorate Organisation for Economic Co-operation and Development (OECD)
09:30–09:45	Interventions to Increase Digitalisation in Food System	**Paul Teng** Managing Director and Dean NIE International
09:45–10:00	Digitalisation for Sustainable Agriculture in ASEAN: Regional Strategy and Policy Pathways	**Venkatachalam Anbumozhi** Senior Research Fellow for Innovation, ERIA
10:00–10:15	Coffee Break	
10:15–10:30	ASEAN-Japan MIDORI Cooperation Plan Focussing on Smart Agriculture and Other Innovative Technologies	**Hideyuki Morii** Director and Senior Negotiator, Bilateral Affairs Division, Export and International Affairs Bureau, MAFF, Japan

Time	Agenda	Resource Person
10:30–12:00	Panel Discussion Various Sector's Experiences on Promoting Digital Technologies in the Agriculture and Food System	Panellists: **Paul Nicholson** Olam Agri and At Source (virtual) **Chrissa Marey Borja** Grow Asia **Eiji Matsubara** Japan Association for International Collaboration of Agriculture and Forestry (JAICAF) and ADCA **Tien Nguyen** Sagri Co., Ltd **Anh Phong Nguyen** Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD) **Thanatchai Sriply** TCS AgroTech Moderator: **Paul Teng**
12:00-13.30	Lunch Break	
13:30–14:45	Country Presentations Best Practices (Production and Supply Chain), Challenges and Opportunities, and Policy Instruments for Promoting Digitalisation of the Agriculture and Food System	Delegate from Brunei Darussalam Delegate from Cambodia Delegate from Indonesia Delegate from Japan Delegate from Lao PDR
14:45–14:55	Q&A, Discussion	
14:55–15:10	Coffee Break	
15:10–16:25	Continuation of Country Presentations	Delegate from Malaysia Delegate from Myanmar Delegate from the Philippines Delegate from Thailand Delegate from Viet Nam
16:25–16:35	Q&A, Discussion	
16:35-16:45	Wrap Up and Way Forwards	ASEAN Secretariat
16:45–16:55	Closing Remarks	MARD, Viet Nam MAFF, Japan
19:00	Welcome Dinner	

Day 2, 1 October 2024

	Destination	Note
8:00–12:00	Field Trip 1: Trang Linh Company – Applying Technical Advances and Digital Technology in Livestock Farming	All Participants
	Field Trip 2: Loc An Port – Applying Information Technology in the Ship Navigation System Using Actual Data from Fishers	All Participants

ANNEX 2
Programme of the Symposium

Table A2.1: Digitalisation of the Agriculture and Food System in ASEAN Member States

Initiatives	Challenges	Opportunities	Policy Instruments
Brunei Darussalam			
• **Internet of things (IoT)**. Sensors are used to monitor temperature, pH levels, and control-released fertiliser applications for optimised crop management • **Drone utilisation for crop monitoring and spraying**. Drones are used to monitor crop health and to precisely spray pesticides and fertilisers • **Agriculture Information Management System (AIMS).** AIMS collects data and analyses trends to support decision-making and to improve agricultural productivity.	• High costs for small-scale farmers. • Complexity in technology integration, especially for ageing farmers. • Lack of technical skills for maintaining technology. • Infrastructure limitations, especially in rural areas, such as unreliable internet and electricity, hampers the implementation of digital agricultural tools.	• Increasing efficiency and reducing labour. • Farming sustainably through precision farming. • Collaborating on research with tech firms. • Enhancing resilience through early-warning systems and predictive analytics. • Collaborating on innovative crop management solutions between tech firms and academic institutions.	

Initiatives	Challenges	Opportunities	Policy Instruments
Cambodia			
• **Digital soil mapping.** This technology aids in identifying land capability and stability • **Deep-learning model of convulutional neural network.** This technology provides prcise maps of crops such as cashew, cassava, black pepper, and mango, through digital imagery. • **Remote-sensing data collection and spectroscopy.** Data are provided to monitor soil organic carbon, greenhouse gases (GHG) and co-benefits. • **Cambodian GIS (CamGIS).** Data are provided on the composition of soil, pH, and soil organic carbon. • **CAMAgriMarket.** This app improves agriclutural stakeholders' ability to access, gahter, analyse, and utilise information to better respond to market needs.	• Climate change. • Limitations of production, technical support, and transferring technologies. • Market competition in value chains.	• Adopting climate smart agriculture and precision farming through technology. • Encouraging public-private partnerships (PPPs) to enhance agricultural productivity and socio-economic efficiency. • Developing modern agricultural cooperatives and deploying commune agricultural officers (CAOs). • Smoothing financial mechanisms for agriculture (market access, price stabilisation).	**Implementation of government priority policy programme nos. 5 and 6 on agriculture:** • Promote agricultural productivity, market accessibility, and price stabilisation. • Deploy CAOs at the local level. • Encourage financial mechanisms for agricultural development.

Initiatives	Challenges	Opportunities	Policy Instruments
• **AgriLibrary.** This app provides access to a repository of agriculture-related documents, including technical manuals and agricultural guidelines. • **CARDI Tech.** This app provides information on research and application of agricultural techniques established by the Cambodian Agriculture Research and Development Institute.			
Indonesia			
• **Standing Crop Information System 2.0 (SISCROP 2.0).** This technology provides real-time data on crop health and growth patterns through a remote-sensing information system • **Drones and sensors.** These technologies are used for precision tasks like spraying crops and monitoring soil, water, and weather conditions.	• Challenges in data verification: Satellite data must be cross-checked with real-time field conditions to ensure accuracy.	• Improving crop productivity and yield prediction with interactive data available to support decision-making. • Gradually implementing smart-farming technologies, enhancing efficiency and sustainability in agriculture.	• **Minister of Agriculture Regulation No. 40 of 2019**. Provides guidelines for an agricultural information system to enhance agriculture activities. • **National Medium-Term Development Plan, 2020–2024.** Incorporates strategies for the digitalisation of agriculture through information technology.

Initiatives	Challenges	Opportunities	Policy Instruments
• **Iot and digital platforms.** These aid in smart irrigation, livestock tracking, and yield optimisation through automated systems. • **Smart Farming 4.0.** This holistic approach emphsises community involvement, infrastructure development, and research and development (R&D) for agricultural innovation.	• Limited technical knowledge amongst farmers. • Infrastructure limitations, particularly connectivity issues in rural areas, and high initial investment costs. • Limited operators and delays in inputting data across regions, limiting the effectiveness of real-time monitoring. • Access to financing like credit access and different risk perception. • Data and technology integration featuring inaccurate data management. • Data privacy and security related to data protection in digital practice. • Regulatory and policy barries. • Coordination amongst stakeholders.	• Encouraging PPPs to accelerate digital adoption and to drive agricultural innovation. • Collaborating with tech firms and academia for further innovation in agriculture.	• **Law No. 16 of 2006**. Regulates agricultural extension, promoting information and communications technology (ICT) to improve farmers' knowledge. • **Minister of Agriculture Regulation No. 48 of 2020.** Offers policies on using digital technology in agriculture, focussing on farmer training and capacity building • **Law No. 19 of 2016 (ITE).** Establishes a legal framework for ICT use in agriculture, ensuring data security and integrity. • **Government Regulation No. 6 of 2018:** Focusses on agricultural information systems for decision-making and sector development through ICT. • **Minister of Communications and Information Regulation No. 11 of 2018.** Supports ICT infrastructure development for rural internet access in agriculture.

Initiatives	Challenges	Opportunities	Policy Instruments
			• **Presidential Regulation No. 95 of 2018.** Promotes ICT use in government, including agriculture, to boost efficiency and transparency.
Lao PDR			
• **Laos Climate Service for Agriculture (LaCSA).** This service provides climate data,crop modelling, forecasting and Advisory services. • **Climate change training and agriculture adaptation modules.** • **Journal of Agriculture and Forestry.** The journal dissemiates information. • **Lao CAT.** This database of sustainable land management practices also features a biodiversity database. • **Geographic Information System (GIS).** Thisystem aids in policy support and land-use data sharing.	• Limited internet accessibility and affordability in rural and remote areas hinder adoption of digital agriculture • Technology capability, knowledge and skills limitations. • Limited experience with modern agriculture technologies. • Limited capacity for data collection • Limited internet access and affordability in rural areas. • Limited capacity within farm communities for data collection, record keeping, planning, and technologies and tools. • Limited capacityfor extension workers to use tools.	• Enhancing agriculture productivity through modern technologies. • Promoting climate resilience and sustainable practices using digital tools. • Supporting farmers with real-time weather risk warnings and advice. • Developing open-access databases promoting knowledge sharing on biodiversity and sustainable practices.	• **Agricultural Development Strategy to 2025 and Vision to 2030**. Modernises agriculture.

Initiatives	Challenges	Opportunities	Policy Instruments
Malaysia			
• **Precision agriculture**. Variable rate technology is used for pricese fertilisation processes. • **Drone technology.** These are used for mapping, spraying, and yield monitoring systems. • **Global Navigation Satellite System.** The system acquoires data and generates land levelness maps. • **Early-warning system.** This alerts for brown planthopper outbreak enabling timely responses to impliment measures and to minimise impact. • **MakGeoPadi.** This integrated GIS and remote-sensing system monitors paddies. • **Paddy seed optical colour sorter.** This screens for and isoliates impurities (e.g. immature paddies, foreign matter, weedy and chalky seed). • **Post-harvest mechanisation and automation.** IoT and QR codes are used for quality certification.	• Infrastructure readiness. Most agricultural technologies are still in the R&D phase. • Limited skilled workers for digital technology adoption. • Time needed to develop skilled workers and to commercialise technology. • High cost of technology that needs technology acquisition, training, and facilities as well as R&D. • Technology could replace humans and reduce job opportunities that causing social conflict. • Connectivity issues • Cybersecurity threats due to weakness in network systems and hacker threats.	• Generating more precise data using GIS and satellite images • Creating digital images of rice-planting stages for field monitoring by agriculture officers. • Enhancing precision in seed distribution, improving paddy yields and reducing resouce waste. • Increasing the efficiency of fertiliser use, leading to improved productivity and cost savings for farmers. • Impriving pest management with early warning systems. • Increasing traceability and quality control in seed production with IoT integration.	• **Establishment of Ministry of Digital and National Digital Department (2023)** • **Public Sector Digitalization Strategic Plan, 2021-2025.** • **Public Sector ICT Strategic Plan, 2021-2025**. Sets the strategic direction of digitalisation for public sector agencies for 3-5 years.

Initiatives	Challenges	Opportunities	Policy Instruments
Myanmar			
• **Website.** It stores information on regulation, technology, information, conferences, and data on Myanmar's agriculture. • **Agri-input technology.** Data are stored on crops and seeds as well as weather forecasts. • **E-services.** E-certificates are issues for the registration of seeds, fertilisers, and pesticides. • **E-government.** Training is provided for ICT, including workshops. • **Department of Agriculture Agri-Chatbot.** The chatbot provides assistance and information to farmers. • **Mobile phone app.** The app helps farmers obtain agricultural knowledge and information.	• Fragmented digital intiatives. • Under-developed digital infrastructure. • Low internet connecitivy, especially in rural areas. • Limited farmer knowledge of advanced technologies like AI, sensors, or robots. • Limited capacity of applying digital agriculture because digital agriculture interest in Myanmar is only 44.1%. • Lack of skilled ICT staff for scaling digital solutions. • Financial contraints for developing infrastructure and training programmes.	• Increasing mobile and smartphone ownership amongst farmers. • Growing mobile coverage in rural areas, allowing better communication between farmsers and extension workers. • Potential for expanding ICT applications in agriculture. • Strengthening connecitivity via SMS and mobile networks. • Developing opportunities for capacity building in digital agriculture and infrastructure improvements.	**Long-term development programme for ICT** • Provides access to a wide range of tools and services. • Encourages private sector involvement in the development of digital agriculture technologies.

Initiatives	Challenges	Opportunities	Policy Instruments
Philippines			
• **Remote sensing and drones.** These technologies are used for precision agriculture such as crop monitoring, damage assessment, and seeding. • **e-Kadiwa.** This project assists the government in plands and programme formulation on enterprise development. • **Registry System for Basic Sectors in Agriculture (RSBSA).** RSBSA is a reference for programme planning, implementation, monitoring, and formulation of policies in agriculture. • **Farm automation robotics.** IoT is used for rice paddy microclimate and water quality monitoring and automation of water gates. • **Philippine Rice Information System (PRISM).** PRISM uses satellite imagery to monitor rice-growing areas and to accurately map rice fields.	• Fragmented digital platforms leading to confusion and low adoption amongst farmers • Lack of infrastructure to support widespread adoption of digital technologies. • Low digital literacy amongst farmers and limited familiarity and applications. • High cost for technology adoption and limited access to digital resources for smallholder farmers. • Cybersecurity issues, including data privacy and protection. • Limited political framework supporting full-scale digital agriculture transformation.	• Growing interest in digital agriculture to foster collaboration with other ASEAN Member States. • Innovating through R&D in farm automation, robotics, and precision agriculture. • Integrating data systems to allow better coordination across agricultural stakeholders. • Helping farmers with decision-making using digital agriculture.	• **National Information Network** enhancement. • **Private sector collaboration** encouraged for innovation and investment.

Initiatives	Challenges	Opportunities	Policy Instruments
Philippines			
• **Digital Fisheries.** The Vessel Monitoring System monitors fisheries and the marine environment. • **Artificial intelligence (AI).** A natural language chatbox provides real-time data analysis and crop management recommendations as well as helps farmers manage supply chains. • **Trading Post Commodity Volume Watch.** TPCVW provides supply information and analyses trends for the Supply Monitoring Team. • **Bantay Presyo Monitoring System (BPMS).** BPMS provides price information for agriculture and fishery commodities.			

Initiatives	Challenges	Opportunities	Policy Instruments
Thailand			
• **Ministry of Agriculture and Cooperatives (MOAC) smart farming.** Technology-driven agricultural practices, such as the Decision Support System, IoT systems, drones, and automation machinery enhance productivity, sustainability, and efficiency in farming operation. • **Smart greenhouse.** The technology helps manage temperature and humidity, uses monitoring sensors for soil moisture and irrigation automation, and collects data for growing practices. • **Mobile apps.** These apps provide farmers with information on agricultural practice guidelines, monitoring tools, and remote assistance, aiming to enhance accessibility to agricultural data and technology	• Farmers' literacy in digital technology • Limited fiscal budget. • The current structure of government agencies may not be optimised for efficient coordination in implementing digital agriculture policies, leading to delays or overlaps in responsibilities. • Limited infrastructure that supports adoption of digital technologies. • Political instability. • High cost of technologies. • Integration of operations amongst stakeholders	• Building capacity and knowledge transfer, including workshops, training, and pilot projects. • Building PPPs for R&D, market expansion, and funding. • Consolidating apps into a national platform for more accessible and efficient use. • Seeking support from private sector startups and government R&D initiatives	• National Master Plan 2010–2013. Provides a roadmap for implementing policies and initiatives aimed at modernising the agricultural sector. • National Economic and Social Development Plan, 2023–2027. Promotes sustainable economic growth, social equity, and environmental conservation, outlining strategic goals and actions for various sectors, including agriculture. • National Strategy, 2018–2037. Aims to enhance competitiveness, foster innovation, and ensure environmental sustainability. • Action Plan of the Ministry of Agriculture and Cooperatives. Seeks to enhance agricultural productivity and improve food security.

Initiatives	Challenges	Opportunities	Policy Instruments
• **Agritech startup.** Novel farming systems utilise digital technology for biotechnology, post-harvest logistics and tracebility, and marketplaces. • **THAGRI.** A digital platform connects farmers to share data and information on the agricultural sector. It works as data collaboration platform among farmers and consumers.			
Viet Nam			
• **Mobile app for farmers.**This helps them monitor crops and agriculture, and for e-commerce purposes. • **ICT water managment network.** This measures water levels and manages irrigation systems. • **Thematic mappter data display system.** It can be accessed through mobile phones.	• Lack of infrastructure for food production and processing. • Limited technology for processing agricultural products. • Limited investment in digital technology due to high cost and fragmented resources. • Awareness and institutions in digital transformation not comprehensive.	• Linking e-commerce value with agriculture logistics. • Enhancing farmer literacy through vocational training. • Strengthening communication of digital transformation policies. • Developing e-government to improve public service in agriculture. • Cultivating research, cooperation, training, and knowledge transfer for digital literacy.	• **Commitment on digital transformation** based on the 13th National Congress • **Orientation of National Congress 2024** National Committee of Digital Transformation focussing on the ICT industry, digitisation of economic sectors, digital management, and digital data.

Initiatives	Challenges	Opportunities	Policy Instruments
Viet Nam			
• **Viet Nam IV (VIV).** A platform connects professionals in the animal protein supply chain, from feed to food. • **SENDO.** This e-commerce platform is used for consumer-to-consumer and business-to-consumer as well as the agriculture market. • **Forest Resource Monitoring System (FRMS).** This system monitors and manages forest resources. • **Fishery Monitoring System.** This system manages and tracks fishing vessel activities. • **Rice Activity Monitoring and Reporting (RiceMore).** RiceMore standardises and records rice production activities. • **Smart village model.** This is a digital technology for land management, irrigation, farming, and animal husbandry.	• Institutional frameworks incomplete, including data law, digital transformation in agriculture. • Establishment of big data systems in agriculture is hindered by fragmented data. • Software management is diminished by insufficient data sharing and integration among systems. • Poor digital infrastructure in rural areas	• Developing digital transformation due to the massive number of internet users, households having computers, and persons that have access to the internet. • Potentially utilising the technology infrastructure in rural areas	

Table A2.1: Digitalisation of the Agriculture and Food System in ASEAN Member States

Project	Country Implementation	Description	Challenges	Recommendations
Smart Irrigation System Technology for Fruit Trees	**Thailand**	A pilot project to demonstrate precise irrigation sensors and controllers. Training for government officials in Japan starts in October.	**Data limitations.** Insufficient data hinder the development of effective digital agriculture solutions.	• Foster public-private partnerships (PPPs) for funding and collaboration. • Conduct research and development for technology innovation.
Automatic Plotting Technology and Soil Diagnosis of Farmland Using Satellite Data	**Thailand Philippines** (will be implemented following Thailand's demonstration) **Indonesia** (identified for future demonstration)	Plot farmland borders using artificial intelligence (AI) and satellite images. Diagnose soil conditions and evaluate crop growth for each farmland compartment.	**Ageing farmers.** Low-interest funding. Limited access to low-interest loans reduces investment in digital tools.	• Build capacity for technology adoption and knowledge transfer. • Develop more practical policies for technology adoption.
Tractor Mechanisation	**Thailand**	Operate tractors automatically and accurately using a cutting-edge steering system. Utilise GPS technology in the tractors.	**High costs for technology transfer in ASEAN.** Adapting technologies in ASEAN Member States is expensive, slowing adoption.	

Project	Country Implementation	Description	Challenges	Recommendations
Joint Crediting Mechanism (JCM)	**Viet Nam** (implementation under review) **Philippines** (draft JCM methodology for alternate wetting and drying [AWD])	Japanese private companies support AWD in partner countries, leading to reduced greenhouse gas (GHG) emissions and increased farmers' incomes. Supported by the Asian Development Bank.	**Complexity of tech transfer in ASEAN.** Diverse conditions across ASEAN make it difficult to transfer digital technologies.	
AWD Using Information and Communications Technology (ICT)-based Water Management	**Cambodia** (using ICT-based water management) **Lao People's Democratic Republic** (using irrigation faucets with float valve outlets) **Viet Nam** (using ICT-based water management)	Utilise agricultural water management techniques such as AWD and paddy field dams to reduce GHG emissions, agricultural labour, and water usage while mitigating flood damage		
Ministry of Agriculture, Forestry and Fisheries (Japan)-funded Project on Sustainable Wood Use Promotion in Timber-producing Countries	**Malaysia**	Focus on improving value-added wood products such as furniture.		

Project	Country Implementation	Description	Challenges	Recommendations
Circular Agriculture through PPPs	**Thailand**	Demonstrate cassava cultivation technology developed by private companies. Establish sustainable agriculture based on correct cultivation knowledge.		
Capacity-building Activities of Durian Farmers	**Malaysia**	Introduce smart agriculture practices such as using drones, climate/soil data, and tree identification with QR codes.		
Food Value Chain Development Project	**ASEAN Member States**	Create recommendations and guidelines on good agricultural practices (GAP), sanitary and phytosanitary standards (SPS), good aquaculture practices (GAqP), and PPPs for promotion of the food value chain in ASEAN.		
Monitoring, Reporting, and Verification System for GHG Emission Reduction	**Cambodia**	Monitor water level of rice paddies with satellite data and AI analysis.		
Cashew Nut Shell Liquid (CNSL)	**Viet Nam**	Joint research in Viet Nam has shown that CNSL feed reduces methane emissions by 20%.		

Project	Country Implementation	Description	Challenges	Recommendations
Agroforestry Practice in Coffee Production	**Lao People's Democratic Republic**	Integrate trees into farming to increase biodiversity, soil health, and carbon sequestration.		
GHG Reduction in Livestock Sector	**Viet Nam**	Optimise technology for livestock feeding.		
Capacity Building Project on Illegal, Unreported, and Unregulated Fishing Countermeasures	**ASEAN Member States**			
Smart Greenhouse Horticulture Technology	**Viet Nam**	Deploy highly productive environmental control technology.		
Research Project on Low-cost Agricultural Production Systems	**Thailand**	Utilise environmental control systems such as plant factories.		
Machine Learning and Remote Sensing-based Water Management	**Indonesia Viet Nam**	Adopt numerical and machine learning models, remote sensing technologies, and information and communications technology (ICT) for real-time monitoring and forecasting systems for water, farmland, and crop conditions.		

Project	Country Implementation	Description	Challenges	Recommendations
ICT Water Management Network and Utilisation of Viet Nam Academy for Water Resources (VAWR) TM Data Display System	**Viet Nam**	Utilise water sensors for the irrigation system (pump and gravity). Measure the water level. Reduce methane emissions through AWD in paddy area. Measure storm intensity during Typhoon Molave. Measure water level during Typhoon Yagi for intervention suggestions.		

ANNEX 3
DIGITAL TRANSFORMATION IN LIVESTOCK AND FISHERIES – FIELD VISITS

Trang Linh Company. Participants visited the Trang Linh Company to learn about the company's adaptation of digital technology in the livestock business. The company has 70 hectares and over 40,000 pigs. It has adopted advanced technology to ensure the sustainability of its livestock and market supply. One lesson learned is the critical role of technology in enhancing productivity and promoting sustainability. Innovations, like biological litter and BioGill membrane technologies, demonstrate that modern solutions can effectively address contemporary agricultural challenges while reducing costs. Economic viability is another important takeaway. The adoption of environmentally friendly practices, such as biological litter technology, has led to significant reductions in water and labour costs, proving that sustainability can align with profitability. This underscores the necessity of viewing waste as a resource, exemplified by the Trang Linh Company's successful production of microbial organic fertiliser from solid waste, which contributes to a circular economy. Moreover, adaptability to local conditions is essential for success. The company's use of polyvinyl chloride (PVC) plastic roofing and advanced cooling systems highlights the importance of tailoring solutions to specific environmental needs, improving both animal welfare and operational efficiency. Finally, collaboration is crucial for achieving agricultural advancements. Its strategic partnership with De Heus Animal Nutrition illustrates how working with experts can enhance the effectiveness of technology adoption, providing essential support to farmers in modernising their practices.

Loc An Port. The participants visited Loc An Port to observe digital technology in the fishery sector, provided by TComie. In collaboration with the Viet Nam Institute of Fisheries Economics and Planning, TComie has integrated satellite and mobile apps to enhance communication and operational efficiency in fishery management. Embracing technologies, such as e-logbooks and navigation systems, is essential for modernising fishery management and improving operational efficiency. The use of real-time data sharing has significantly enhanced communication, particularly in areas with limited internet access. Effective collaboration amongst key stakeholders, including fishers and regulatory authorities, is critical to the successful implementation of digital solutions. Additionally, providing adequate training ensures that users can fully leverage these technologies, maximising their benefits. These initiatives also underscore the importance of adopting a comprehensive approach to fishery management, where integrating various digital tools simplifies processes and enhances overall outcomes. As these technologies evolve, they offer significant opportunities for scalability and sustainability, contributing to a more efficient and responsible fishery sector.