Workshop Summary Report

APEC Workshop on Promoting Digital Transformation in Agriculture

APEC Digital Economy Steering Group

March 2024

Asia-Pacific
Economic Cooperation

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APEC WORKSHOP ON PROMOTING DIGITAL TRANSFORMATION IN AGRICULTURE

Ha Noi, Viet Nam

28 & 29 September 2023

Workshop Summary Report

I. Introduction

On 28 & 29 September 2023, the ***"APEC Workshop on Promoting Digital Transformation in Agriculture"*** was held in the hybrid format. The project was led by Viet Nam and co-sponsored by Chile; China; Papua New Guinea; Chinese Taipei; the United States. Speakers and participants came from the private sector, business associations, international organizations, research institutions, and APEC economies' relevant Ministries and government agencies.

The objective of the "***"APEC Workshop on Promoting Digital Transformation in Agriculture***" is to improve capacity building for APEC member economies, especially developing ones to promote digital agriculture through sharing information, experiences and practices in promoting innovation and uptake of technologies with views of pursuing and ensuring agriculture with sustainability, inclusiveness and responsibility.

II. Background

It is indicated that agriculture gross domestic product (GDP) per capita in developing economies is just one-tenth that of developed economies. [1] According to the World Bank, agriculture faces difficulties and challenges especially in the COVID-19 pandemic when shelves are empty elsewhere but farmers still have to destroy their food due to surplus of production. [2]

Digital agriculture could play an important role in improving agriculture productivity, sustainability and inclusiveness since it could help improve yields, cut food loss and waste, improve resource efficiency, sell the right products to the right markets and get fair pay, and so on through providing farmers with right

[1] Nugroho A.D. (2021): Agricultural market information in developing countries: A literature review. Agric. Econ. – Czech, 67: 468–477

[2] https://www.worldbank.org/en/news/feature/2021/03/16/a-roadmap-for-building-the-digital-future-of-food-and-agriculture

information and tools (such as precision agriculture) in a timely manner as well as improving tracking of produce from farm to consumer, which in return, help ensure sustainable and responsible agriculture. [3]

In particular, digital agriculture – an integration of the science of genomics and genetics, soil nutrition and crop science, meteorology and hydrology, software engineering, cyber-physical hardware design and manufacture, agribusiness and innovation in business models, finance and investment, supply chain logistics, market research and marketing[4] would help farmers and relevant stakeholders in the agriculture value chain to harness relevant resources to improve production.

Despite great contributions of digital agriculture, it is not easy for farmers and economies to access digital transformation in agriculture, especially in developing economies since they have limited resources and experiences to promote digital agriculture. This project will focus on providing capacity building for APEC member economies and developing ones through identifying challenges that APEC member economies encounter with in relations to adoption and implementation of digital agriculture; sharing information, experiences and practices in promoting innovation, uptake of technologies, and formulation of policies, incentives to promote digital agriculture as well.

This project is in line with the APEC Leaders' 2021 Declaration to pursue digital connectivity and innovation: "Digital connectivity and innovation are critical across our efforts towards an inclusive, resilient and sustainable recovery" and "we will accelerate the implementation of the APEC Internet and Digital Economy Roadmap (AIDER), further develop digital infrastructure, encourage the development and application of new technologies, and work towards a digital business environment that is open, fair and inclusive, including by narrowing the digital divide" to ensure to "support the wellbeing and security of all our people, and their equitable participation in the economy, so that no one is left behind".

It is also aligned with the Putrajaya Vision 2040 and Aotearoa Plan of Action (APA) since it contributes to bringing "palpable benefits and greater health and wellbeing to all, including MSMEs, women and others with untapped economic

[3] https://www.worldbank.org/en/news/feature/2021/03/16/a-roadmap-for-building-the-digital-future-of-food-and-agriculture
[4] https://qaafi.uq.edu.au/blog/2019/01/what-digital-agriculture

potential.” In developing economies, while agriculture plays an important role in poverty reduction, women and farmers with limited resources (in small scale, lack of capital, knowledge, and technologies) represent a large proportion. Providing capacity building for these will help unleash their potential and improve productivity.

This project will directly contribute to addressing areas such as promoting innovation and adoption of enabling technologies and services and enhancing inclusiveness of Internet and Digital Economy under the APEC Internet and Digital Economy Roadmap (AIDER), with views of improving the flow of goods, services, capital and technology within the region.

III. Key Issues

1. Overview of digital transformation in agriculture in APEC member economies

Dr Tzong-Ru Lee, Professor of Marketing Department, Chung Hsing University (NCHU); Chairman, International Association for Agricultural Sustainability (IAAS): The United Nations (UN) refers digital agriculture as “the use of new and advanced technologies, integrated into one system, to enable farmers and other stakeholders within the agriculture value chain to improve food production”. Digital technologies hold significant capabilities to enhance the efficiency, equity, and environmental sustainability of the agri-food system through improving on-farm production and assisting farmer decision making; Improving off-farm process, and lowering transaction costs; improving environmental sustainability through resource efficiency; offering consumers greater transparency information about agricultural products; and fair distribution of data, fair pay for farmers.

The speaker explored the development in some economies to get a more in-depth understanding of digital agriculture in the APEC region. Viet Nam is an example. Viet Nam embraces favorable conditions to promote digital agriculture given the facts that 99% of rural and urban Vietnamese have access to electricity, 90% of farmers have mobile phones, 46% of the population and 10% of farmers use broadband internet, and Viet Nam is ranked as the 3rd in the world about the affordability of the internet with the cost less than USD3 per month (Burra et al.,

2021). Also, according to the report, technologies are required for digital agriculture from various angles such as for input hub; producer hub; production and distribution hub; and cross-cutting hub. Those should include advanced analytics for accurate market information, blockchain for traceability, digital diaries for financial decision support (for input hub); cloud-based solutions for data sharing, SMS/IVR systems for decision support, Internet of Things (IoT) for decision support, unmanned aerial vehicles for monitoring farming systems and landscapes (for producer hub); advanced analytics for customized solutions, cloud-based solutions for improved information access (for production and distribution hub); and mobile applications for integrated solutions, online market and price information platform, QR Codes for traceability (for cross-cutting hub) (Burra et al., 2021).

Viet Nam has developed digital agriculture zones such as those in Bac Ninh, Vinh Phuc, Thai Nguyen, Lam Dong, Ho Chi Minh City, the Mekong delta, and so on. Some enterprises in agriculture such as VinEco, TH True Milk, Vinamilk, Cau Dat Farm, etc., have been able to successfully deploy digital transformation to promote their production for competitive growth and development. For example, using Unmanned Aerial Vehicles (UAV) to spray pesticide, or remote farm monitoring 24/7 are among those widely applied with remote temperature and humidity monitoring system, misting system, ventilation fan, automatic sun shear control, automatic nutrition pumping system, and farm traceability management platform, etc., which is helpful to improve productivity and efficiency.

In the case of Chinese Taipei, they have developed policies to promote digital agriculture, namely:

- Promoting the clustering of agricultural technology industries: include development of multifunctional warehousing zones; multifunctional living services areas, etc.
- Promoting Smart Agriculture 4.0: promote wide application of IoT sensor technology, intelligent robots (IR), big data, cloud computing, UAV for spraying pesticide, semi-automatic plant irrigation machines, etc.
- Promoting the industrialization of R&D results in agro technology such as completing 240 cases of digital transformation (e.g.: bacterial strains for

preventing bacterial soft rot in crops and their application); organizing “2018 Innotech Expo” (TIE); exhibiting 41 results of R&D with potential for commercialization, etc.

- Creating “Agricultural Products Value-Added Prototyping Centers” which help to assist farmers through providing expert consultation and training; prototype testing and market evaluations for dried, milled, roasted, and ground agriproducts; developing high-quality and safe processed agriproducts;
- Providing integrated services for agricultural digital information includes making agricultural information available to the public; building a cooperative platform for agricultural spatial information; and modernizing agricultural information.
- Developing circular agriculture with environmental protection and eco-friendly development through reducing plastic use; setting up one place for “Developing the pilot scale multiple hearth furnace with a continuous feeding system for mass production of biochar”; two locations with slope land orchards as demonstration areas for the use of biochar compound fertilizer.

The emergence of the COVID-19 pandemic has reshaped the global supply chains dramatically. While in the pre-COVID 19, the supply chain was stable, it was dramatically disrupted during the pandemic, which resulted in labor shortage, oversupply on the production sides, and lack of food supply on consumers’ side. During the pandemic, technologies were applied to address labour shortage, and online shopping as well as establishment of online groups boomed to address social distancing and lockdowns. Following the pandemic, the long supply chains have been replaced by diversified and short ones, partly thanks to changes in consumer behaviour as well as shifts to e-commerce and healthy products.

In the context, digital transformation in agriculture are influenced by various factors. For example, for those farmers who are located near the city, they have the advantages of short distance to end consumers, easier product distribution, therefore, they can focus on developing and/or joining economics communities. In this case, it is necessary and important that farmers should be equipped with

mobile phones, training skills to use mobile phone apps, knowledge on marketing activities on social networks, as well as connection with consumers and economic community development. On the other hand, for those farmers who are located far from cities, they should consider forming and joining cooperatives to address the issues of far distance to end consumers and long time to distribute products. Agriculture cooperatives could bring farmers together to collectively address challenges, pool resources and make efforts to achieve common goals, foster collaboration, and overcome individual small farmer limitations through undertaking collective marketing to pool farmers' harvests, negotiate better prices and access larger markets; promoting knowledge sharing as well as foster access to information thanks to their roles as platform, and a bridge to provide valuable agriculture-related information such as relevant data on weather forecasts, market prices, best practices, and research findings, enabling members to stay updated and make data-driven decisions.

2. Identifying possible and potential tools, technologies, innovation under digital transformation and addressing the challenges in the uptake

Mr Arseny Plosskiy, Deputy Head of Laboratory, Radio Research & Development Institute (NIIR), Russia: Russia has made strong efforts to promote digital transformation in agriculture through making digital, information and telecommunication resources widespread and available across the economy, developing agricultural development projects to support the introduction of digital technologies in the agricultural sector as well as developing digital platforms to provide access to modern solutions and information, which contributes to increasing business competitiveness in the global markets and improving the living standards.

Russia's "Digital Economy" program includes the federal project "Digital Agriculture" in the period 2019 – 2024 which aims to measure performance based on indicators such as: (i) transformation of the agricultural sector through the introduction of digital technologies and platform solutions; (ii) provision of highly qualified personnel training for the digital economy; and (iii) creation of end-to-end digital technologies mainly based on domestic developments. They focus on six (06) directions to promote digital transformation for agriculture including:

digital technologies in the management of agriculture; digital land use; smart field; smart garden; smart greenhouse; and smart farm.

Russia's government supports farmers through a specially developed digital solution platform, which contributes to provide training to enterprises' managers to carry out large-scale industrial transformation with various majors including auditing, benchmarking and adaptation of technical specifications. Another platform that people can access public services is "Gosuslugi" run by the Ministry of Agriculture, which supports public services such as state registration of breeding achievements; pesticides and agrochemicals as well as information about register of grape-growing lands, and so on.

In parallel, various events and forums are hosted to promote digitalization. For example, in October 2022, the 4th Federal IT Forum of the agro-industrial complex of Russia was held, which included an exhibition that presented industry innovations, solutions, products of domestic developers of IT solutions, software, etc. In June 2023, another Forum on digital agriculture was held, reviewing experiences in digitalization of agriculture and agro-industrial complex, as well as opportunities and risks of the industry's development in the new environment.

At the level of business, Russia's enterprises take active roles in promoting and applying digital transformation for their business growth and development. For example, Strizh is the first manufacturer of wireless solutions based on energy-efficient sensors and LPWAN, which provides equipment that includes base stations, modems for temperature, humidity, CO2 control without binding to GSM coverage and works on the plug-and-play principle to promote digital agriculture. The agro-complex "Lazarevskoye" is the largest breeding farm in the Tula region with 60,000 pigs, a meat processing plant for 10,000 tons of meat per year, a 25,000-hectare crop production facility, and a feed mill. They have developed a technology using artificial intelligence algorithms that uses video cameras to weigh pigs and determine their level of health. To implement the project, a dataset was created from video data for 100 days of pig fattening, more than 1,000 frames were manually marked up, algorithms for automatic marking of video recordings were developed and research work was carried out to determine the weight of pigs. This system helps to save about RUB50 million annually.

Russia also promote specific technologies to promote digital agriculture. For example, “Terra Tech” is a subsidiary of “Russian Space Systems”, established in 2017 as a strategic initiative of Roscosmos State Corporation as a commercial operator of remote sensing services and geo-information services. Thanks to the system, large-scale and diverse changes during seasons can be constantly monitored only with the help of space imagery. Analysis of space images helps to plan field works, monitor the condition of lands, record crop failure, select the most productive areas, identify signs of land degradation, etc.

Dr FLAMEÑO, Honorio C., Director and Chief Information Officer, Department of Agriculture- Information and Communications Technology Service, the Philippines: The Philippines Society of Digital Agriculture (PSDA) refers Agriculture 4.0 as a term for the next big trends facing the industry, including a greater focus on decision agriculture, the internet of things (IoT), and the use of big data to drive greater business efficiencies in the face of rising populations, scarcity of natural resources, climate change and food waste.

The Philippines makes a focus on promotion of food sovereignty through the Philippines Agriculture and Fisheries Modernization and Industrialization Plan 2021 – 2030 (NAFMIP), which seeks to balance the production – supply and consumers’ demand for rice, corn, vegetables, and livestock products, while placing local producers, distributors, consumers in control of food system with the aims to promote healthy eating habits and nature-positive food production systems. They develop a strategic framework to implement the Plan with four (04) main pillars:

- Disruption, transformation & enablement: reboot digitalization efforts by aligning current ICT initiatives with priority concerns; centralization of data holdings to create a robust decision support system (DSS); etc.
- Efficiency and optimization: improve the implementation of cost effective digital systems by continuing the assessment and automation of operational processes; strengthen inter-agency and stakeholder linkages and collaborations.

- Synergy and integration: scale-up the use of ICT solutions by intensified mainstreaming in operations; infuse innovations through continued learning and development (L&D) and knowledge transfer.
- Sustainability: continuous upgrade and enhancement of ICT systems and infrastructure to maintain its security, reliability and integrity.

In terms of operation, the roadmap focuses on promotion and implementation of seamless interconnectivity; mainstreaming of multi-platforms; agribusiness links and networks; real-time access to information, precision farms, apps and agri-bots; transparent governance and accountability in the delivery of services; alignment of ICT initiatives in operational processes, policies, R4D, competency development and corporate social responsibility (CSR) collaboration; geo-data basing of agricultural resources and interventions; risk management of ITC resources and services; interoperable systems for ease-of-doing-business, etc.

They also harness various advanced resources to promote agriculture 4.0 such as precision farming; Internet of Things (IoTs); GPS, GIS & remote sensing in agriculture and natural resource management; drones & remotely- piloted aircrafts; farm traceability; open data; Artificial Intelligence (AI) / Machine Deep Learning; business intelligence (BI), data centralization & interoperability; cloud-based services; upscaling & retooling.

Measuring the maturity of government digital transformation efforts involves assessing the progress, impacts, and alignment of initiatives with the goal of improving services, efficiency, and citizen engagement. Government digital transformation is an ongoing journey in which flexibility and adaptability are key to ensuring successful progress towards higher maturity levels.

Mr Hubert Lau, President and CEO, TrustBix, Canada: From the perspective of a business working in digitalization and agricultural sector, TrustBix shares their stories in promoting innovation in agriculture. Their approach is through addressing food insecurity, vertical farming scalability, distressed real estate markets, and affordability for smaller owners/ operators. It is widely recognized that many globalized food supply chains have been permanently disrupted due to war, economic instability and environmental shifts as well as adversely affected by climate shifts such as droughts, flooding, fire and soil degradation, therefore

many economies attach importance to food security and place large scale funds to “onshore” food production solutions.

Agriplay indoor farming system (AFS) is one among solutions offered by the company to address the challenges. The design includes LED lighting that provides the full spectrum of light required to maximize plant growth through its life cycle; use of power over ethernet (PoE) to dramatically reduce energy consumption; custom designed light weight structures that hold the plant to make it easy for operators to work; and online monitoring and management efficiently enable training and assistance to operators to optimize production. This system is domestically manufactured and hence helpful to ensure minimal supply chain disruptions, and operational in any real estate asset, as well as easily installed within commercial buildings. AFS is believed to have more advantages and efficiency in some aspects compared to traditional indoor farm. For example, in terms of required investment capital, it is estimated to cost about from CAD150 to 250 per square feet (sqft) while indoor traditional farm is about 25% to 50% higher than AFS. Average power used to grow a pound of produce is estimated less than 1 KWh for AFS while it might be greater than 15 KW for traditional one. Average cost to grow a pound of produce* is calculated from CAD1.00 to 4.00 while traditional one might be greater than 4.50

3. Sharing experiences, case studies, examples, models of digital *transformation in agriculture*

Mr Hubert Lau, President and CEO, TrustBix, Canada: The speaker shares the case of TrustBIX with a focus on intersection of ESG, sustainable food and technology. It is believed that there has been a shift in business relationship from traditional view to value chain view. For example, from the perspective of value chain, information is required more extensively; the primary focus shift from cost to value/quality. Similarly, while the traditional views focus on commodity, based on supply push and the philosophy of self-optimization, the value chain perspective focuses on differentiated products, demand pull and the philosophy of chain optimization. Digital transformation has created many benefits to both farmers and corporate enterprises. The benefits for farmers are savings from implementation of ESG related technologies; increased revenue through brand and product claims support and validation; and increased sales volumes through

fulfilment of corporate strategic sourcing. For corporate enterprises, they can measure ESG progress towards targets which are relevant to stakeholders and consumers; gain customer loyalty as well as have strategic sourcing of products with specialized attributes. With the presence of TrustBIX, Canada is the first economy in the world to deliver Certified Sustainable Beef through the supply chain. The company has obtained success in ensuring sustainable beef production and delivery of premium beef products from producers to consumers with full information from verified logistics data to provenance and food safety claims. For example, TrustBIX can help track the producers' cattle on behalf of retailers. To sum up, the speaker emphasized on the shift in value in which the food systems are moving from mass commodity markets to specialty markets, creating high-value products. Besides, greater data intensity is of more importance since data about the products are required and demanded to build trust and resiliency rather than just physical products like in the past. Also, premium value creation requires greater interdependence and optimization in the value chain and greater supply chain complexity requires new strategies for market entry, efficient business models and greater digitization.

Mr Nguyen Quoc My, Senior Advisor, An Binh High-tech Agriculture Cooperative, Viet Nam: Mr Nguyen Quoc My shares the current status and development of the traceability management system in Hiep Hoa District, Viet Nam. Hiep Hoa OCOP traceability information portal is one of the efforts by Hiep Hoa District People's Committee to deploy product traceability. Hiep Hoa OCOP information portal is reported to enable product traceability in Hiep Hoa district more convenient, accurate and easily searched by consumers. The system has been applied in a number of products such as meat, agricultural products, and handicrafts, helping consumers to easily look up information about product origin. Hiep Hoa OCOP traceability information portal is built according to Viet Nam standards for product traceability. These standards ensure the accuracy, transparency and reliability of product origin information. The portal ensures consistency and compatibility with other traceability systems, helping to enhance access to international markets for Hiep Hoa district's products. It is also smart, friendly, easy-to-use. Currently, more than 70% of enterprises in the district have been applying product traceability system with more than 1 billion views. The

system supports printing traceability stamps and ensures confidentiality and information security when used. There have been many training courses organized to support staffs on using the system. However, besides advantages, there still remain a great deal of disadvantages when implementing the system such as difficulties in collecting information as almost of the products are from small farmers with small scale; limited budget to implement the system, etc. Since then, the speaker stresses that there should be more training programs on product traceability, the budget should be allocated timely and effectively, to support application of technology and e-commerce sales, and so on.

Dr Yu Qiangyi, Senior Researcher, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China: Dr Yu presented about the digitalization for cropland management in China. Cropland is a complex system that reflects the human use of land for growing crops. It is helpful to understand the location, allocation and spatial pattern of cropland to allocate adequate resources for agricultural development. Satellite and aerial remote sensing are effective approach for cropland management. Land, crop characteristics and human activities are the keys for the digitalization of cropland management. In China, GlobeLand30 starts an era of applying high resolution land cover datasets. In 2010, global cropland area was 1.93 billion hectares. The average cropland area per capital was 0.28 hectares. There were many changes in cropland area between 2000 and 2010. The global cropland area increased by 2.19%, while in China, it decreased by 0.95%. The cropland area in the Belt and Road Initiative region increased 3.73 million hectares, while in China, it decreased 1.95 million hectares. The crop patterns are highly variable due to weather, location and crop types. Multiple cropping increases the challenges for crop pattern mapping. There is a need for linking farmers with their cropland. Traditionally, to collect data, they can ask farmers directly about their cropland such as on-site visiting, face to face questionnaires or annotation on printed maps. However, these methods are time consuming and have huge difficulties in data process. Alternatively, another method has been created to link farmers with their cropland by using digital technology. E-farm is a tool for better observation agriculture land systems, which helps the rural contracted land with right registration and certifications. Crop characteristics and human activities are

highly variable. Therefore, new approaches, such as IoT and crowd sensing are required for the digitalization of cropland management.

***Dr Rujira Deewatthanawong, Senior Research Officer, Thailand Institute of Scientific and Technological Research*:** Thailand divides their agriculture industry into four (04) stages: Agriculture 1.0 (traditional farming); Agriculture 2.0 (when there is use of light machine and agri management practices); Agriculture 3.0 (use of heavy machinery and precision farming management); and Agriculture 4.0 (precision farming and use of digital technology). There are many mobile apps which are developed by Thailand Electronics and Computer Technology Center (NECTEC) to support the digitalization in farm management such as Rice Disease Linebot, Chaokaset, Agri-Map Mobile, FAARMIs, FMC. Also there is a system called HandySense System. The system is developed by NECTEC, DTAC (A telecommunation – technology service provider in Thailand) and Department of Agricultural Extension (DOAE). It can be controlled by a smartphone. The system has soil moisture and temperature sensor, temperature and humidity sensor and light sensor. It can automatically provide water and fertilization. It is connected with sensors to monitor cultivation parameters. The NECTEC FARM Series has Water fit, Bubble Fit, Ambient Sense, Weather Sense. There are also other mobile apps developed by organizations such as Kasettrack, 2in1 GAP, SWOC and Farmbook. In Thailand, people use drone for spraying pesticides, surveying, and monitoring crop health. There are many digital platforms for agriculture products such as Social media, E-marketplace, E-Retailers and E-Fresh market. The key players in agricultural supply chain are farmers, agri coop enterprises, collectors, e-commerce providers, etc. Thailand farmers can coordinate with some logistics service providers for digital marketing such as Lalamove, Line man, Grab, Thai post, Kerry Express, etc. Thailand farmers are active in adopting digital agriculture. For example, an enterprise community producing durians located in Chumphon province of Thailand form a facebook group on their own called Digital Chumphon Durian Group. The group consists of 120 members with a total cultivation area of approximately 1,200 acres. Digital Chumphon Durian Group uses the application “KASETTRACK” to track durian production of the members and uses yield estimation feature to do marketing planning. The KASETTRACK is an application that helps farmers plan

their crop and creates a source of quality agricultural produce that meets standards and safety for consumers.

4. Impetus and institutional-related factors to promote digital transformation in agriculture in APEC economies

***Dr Yu Qiangyi, Senior Researcher, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China*:** China have attached increased importance to establishing digital agriculture in rural areas, and thus have prepared a major comprehensive plan with components that include strategic big data implementation, strategy for rural digital transformation, and fostering “Internet+” agriculture modernization. Government agencies and local administrations in China have achieved stunning results by fostering and promoting digital technology implementations for rural agriculture, which contributes to resulting in new industries and models, continuous improvements in technological innovation capability, improved infrastructures and equipment deployment, initial policy support program development, etc. The digitalization in agriculture and rural areas encompasses revolutionary changes including biological and environmental factors, agricultural processes such as production, operations, management and rural governance. Looking forward, the future development of digitalization in rural areas and agriculture will embrace hard-won opportunities. A global technological and industrial revolution is underway with the accelerated application of Internet of Things, Internet of Intelligence, Big Data, Cloud Computing and other new generation information technologies. This has profoundly altered life style and production patterns, triggering fundamental changes to the economy and industry. Being aware of the new industrial revolution and big data as a fundamental strategic resource behind an innovation engine driven by a new generation of artificial intelligence, China has issued strategies such as the big data research and development plan, the agriculture technology strategy and the agriculture development 4.0 framework. The data collection system for agriculture and rural areas will be in place and serve as a ground work for the space/aerial/ground observation network, fundamental data resources as well as the cloud platform for agriculture and rural development. Through accelerating integration of digital technology with the industrial, production and management

systems in the agriculture, China has made significant progress in digitally transforming agricultural production and management.

***Mr Therapatt Prasansarakij, Senior Technical Academic Officer, Thailand Science and Technology Development Agency*:** Agriculture Technology and Innovation Management Institute (AGRITEC) is a one-stop service center to cater technologies and innovation to support Thailand's agriculture. Since 2016, it has served as a bridge between innovators and farmers to ensure smooth technology adoption. The mission of AGRITEC is to accelerate the transfer and adoption of technologies to farmers; support the life-long learning processes for farmers and communities which shall lead to the creation of knowledge and innovations; enhance manpower development across the value chain; etc. AGRITEC works in close collaboration with other government and non-government agencies to introduce appropriate technologies to farming communities. AGRITEC establishes and connects collaboration networks among agriculture, local communities, public and private sectors. Specifically, it provides know-how and information on agriculture technologies and innovation; give advices and development proper solutions to problems; organize suitable technology training and transfer; foster the learning process for technology utilization and further development. AGRITEC works with the goal to reduce losses, increase productivity, reduce water consumption and energy saving for farmers. It has produced many positive impacts to the society, economy and environment. AGRITEC's role is to develop and adapt technology for precision agriculture; develop training course on precision agriculture for farmers to promote knowledge and technology transfer to farmers through training and demonstrations in learning centers. AGRITEC also provides Smart Farm/Smart Greenhouse since it has plant watering control and weather monitoring system which can control the shading system, moisture of soil, temperature and humidity. For example, the Smart Greenhouse can be applied for many fruits such as tomatoes and durian. In the past, durian growers use their observations on weather and trees in combination with their experiences to manage their produce. Thanks to the system with the recorded data to be exported in numbers and graphs, farmers can harness and manage the system anywhere and at any time. The System is also equipped with self-developed sensors which can produce the

right sensors based on experience of using in hot and humid environments. Another system which has been used by Thailand farmers is “Weather station”. AGRITEC-NSTDA have installed weather stations in 16 orchard farms in Thailand, which enables instruments for precision farming. Weather station is equipped with sensors for measuring temperature, soil moisture, relative humidity and light intensity, anemometer and a rain gauge with real-time data and hence is used in making operational decision on orchard management. Last but not least, Thailand has developed a Training Hub which includes the science park, universities and Government agencies to transfer knowledge and technology, creating learning courses for students, farmers and interested people.

***Assoc. Prof. Dr Pham Thi To Oanh, Director, Department of Policy and Cooperative Development, Viet Nam Cooperative Alliance (VCA), Viet Nam*:** In Viet Nam, the agricultural cooperatives accounts for about 63% of the total cooperative groups. According to a survey, 83.5% of Vietnamese cooperatives consider digital transformation as necessary; 18.9% have a plan to implement a specific roadmap in digital transformation; 68% use at least one of the methods of introducing and selling products online such as: (i) having their own website to introduce products (38.9%); (ii) selling goods on e-commerce platforms such as Tiki, Lazada, Shopee, etc., (20.8%); (iii) advertise products on social networking sites, advertising pages (50.5%); (iv) selling goods in the form of live streaming on digital platforms such as Facebook, Tiktok, etc., (28.3%). Many agricultural cooperatives actively invest in digital transformation applications, such as applying management software for irrigation and production, using the automatic system; collaborating with trading cooperatives, harnessing e-commerce and digital platforms to promote trade. The “Smart Farming” with application of sensing technology, communication systems, data analytics solutions, relevant hardware and software systems, etc., are harnessed to make the production more efficient, and farmers can manage the data to adjust the light, humidity, etc., on time. Digital transformation applications do not only contribute to addressing issues of corporate governance, enhancing production productivity and product quality, but also gaining trust from consumers, and reducing labor efforts. They also can enhance their value when they can sell their products 20% higher prices than other similar products. One example is Kim Long high-tech agricultural

cooperative. The cooperative works under a digitalized process, which updates, learns and applies scientific and technical advances into production, thereby reducing production costs by 20%, reducing labor costs, minimizing impacts from nature, and controlling pests better. At the same time, reducing the use of pesticides on crops by 70% helps improve the working environment and produce safe products. Thanks to the successful application of digital transformation in production and management, after 06 years of operation and development, they have developed about 20 hectares for melon cultivation, providing the market from 1,500-1,800 tons of products with a revenue of VND45 billion annually.[5] Another example is Kon Tum, the northernmost mountainous province in the Central Highlands region, the Central of Viet Nam. The Standing Committee of Kon Tum's Party Committee has issued a resolution on developing high-tech agriculture associated with processing, with a focus on Mang Den area, which has paved the way for granting investment decisions for a number of high-tech agricultural projects. This includes a project on high-tech agricultural production combined with eco-tourism in Kon Plong district, a joint venture between Kon Plong Agri-Tourism Vietnam and 4 Ways Fresh Pty., Ltd., from Australia, and an organic farm project on par with international standards of BIOPAP Co., Ltd.[6]

On the other hand, there remain difficulties when applying digital transformation in farming. For example, the digital transformation process is still slow with the fact that more than 50% of cooperatives have not yet developed specific digital transformation strategies and plans; some cooperatives do not have enough finance to upgrade equipment and technologies that support digital transformation; most cooperatives still operate based on traditional methods, not yet take steps to digitize business processes to move all practical activities to cyberspace; and only a few cooperatives sell on e-commerce platforms, social networks, and sales websites. Cooperatives are less interested in understanding and identifying customers' demand, but focus more on competitors' products. Their awareness of digital transformation is limited; investment costs for digital transformation are rather high and access to funds is still limited; cooperatives lack qualified and specialized human resources for digitalization. The government

[5] https://www.vietnam.vn/en/binh-duong-thuc-day-chuyen-doi-so-vao-linh-vuc-nong-nghiep/
[6] https://vir.com.vn/kon-tum-spurs-high-tech-agriculture-development-71133.html

do not provide enough specific support and preferential policies for cooperatives to undertake digital transformation efficiently and effectively.

It is necessary that the government should develop mechanisms and/or policies to support digital transformation in agriculture in terms of capacity building, finance access, uptake of digital technologies as well as promote cooperatives' roles through accelerating links and network connection.

5. Sharing experiences from experts and APEC participants

***Miss Jatuporn Nontasiri, Director of Geo-Informatic Centre under the Centre of Agricultural Information, Office of Agricultural Economics, Thailand*:** Ms Jatuporn works for Ministry of Agriculture and Cooperatives (MOAC). Her office is responsible for developing policies and plans relevant to the agricultural sector in collaboration with involved agencies. The global population is increasing which leads to the increase in global food demand. However, the total arable-land area is not increasing. Rising global temperature also threatens crop yields of critical food crops. Therefore, technology innovation is strongly required. In other words, the smart farming that utilizes advanced technology such as robotic, sensing, information and communication technology is strongly needed. Precision Farming has been one of the most advanced applications of remote sensing to agriculture. Remote sensing has been applied to agriculture since 1972. Nowadays, UAVs equipped with an imaging sensor are playing a more important role in digital smart agriculture. This technique can be a key element driving improvements in agricultural precisions and contributes to increasing crop productivity. UAV enables fasters, more flexible and more convenient responses to crop-related problems. It can map larger crop fields and facilitate efficient data collection by using different sensors. It can also operate even on cloudy days and capture crop information in higher spatial and temporal resolution. Thailand has well harnessed UAV application to boost their development. For example, the first case is rice yield estimation based on Sentinel-2 (optical sensor) and Sentinel 1 (Synthetic Aperture Radar: SAR). The 2nd case is oil palm classification by using AI in Surat Thani province, Thailand. Thailand is also adopting Crop Growth Model for yield prediction, which are inputting the essential parameters such as planting dates, weather, etc. It needs a higher resolution satellite (HRS) image to improve the quality of AI results. In

that sense, the satellite-based system for local agricultural applications should be designed, developed and operated through the collaboration of the involved agencies, business sectors and remote sensing specialists.

Mr. Muhammad Ikrami Salehhuddin, Assistant Secretary, Policy & Strategic Planning Division, Ministry of Agriculture and Food Security, Malaysia: In Malaysia, the Paddy Geospatial Information System can provide high resolution satellite images to identify the actual area of rice planting area. The collaboration between Department of Agriculture (DOA) and Malaysian Space Agency (MySA), enables to integrate administrative boundary information, irrigation scheme, information on rice paddies and paddy lot monitoring (including land preparation, irrigation, planting and harvesting). In Malaysia, there is a Smart SBB Program, which can utilize drones and transplanters. It can cover 11,000 hectares and benefits more than 1,000 farmers. However, the large-scale SMART Paddy Field (Smart SBB) need the collaboration between government and private sectors. This program can increase rice yield by up to 150% in some areas, hence elevating farmers' income. Another program in Malaysia is Digital Agriculture Technology Program (Digital Agtech) is a program by Malaysia Digital Economy Corporation (MDEC), in collaboration with stakeholders and ecosystem partners. This collaboration has yielded 15 successful pilot projects, empowering over 15 Farmers' Area Organizations and training 1,500 farmers in Malaysia. To sum up, the digitalization ushers in a future of smart farming for sustainability. The undeniable power of data has the potential to revolutionize decision-making.

IV. Discussion, Recommendations and Conclusions

Through the active sharing of information and experiences at the Workshop, speakers and participants exchanged views on how to promote digital transformation in agriculture. Recommendations are summarized as below:

- Enhance farmers' awareness and access to information technology, including having fundamental digital skills and devices (such as mobile phone and internet), promoting and using social media and networks, etc.;
- Enhancing the digital infrastructure;

- Support financial support to promote farmers to apply advanced technologies and technique for their farm management;
- Establish and promoting roles of agricultural cooperatives to bring farmers together to collectively address challenges, pool resources and efforts to achieve common goals, foster collaboration, and overcome individual small farmer limitations;
- Enhance roles of other stakeholders including local authorities, institutions, and associations to promote farmers' access to information, finance, technologies, and support, improving their capabilities in farm management, digital marketing, etc.;
- Promote R&D, establish kinds of agri-tech and innovation centres to promote application of technology and innovation in agriculture, incubation of ideas and training to support farmers;
- Promote precision farming to enhance productivity;
- Encourage engagement of young labourer in agriculture to foster resources, creativeness and innovation in agriculture, which is important to improve productivity and competitiveness; and so on.

Hereinabove are some recommendations from the workshop's participants and speakers that require further thoughts and discussions at the upcoming DESG meetings to transform into more concrete and practical activities.