



**Asia-Pacific
Economic Cooperation**

Advancing Free Trade
for Asia-Pacific **Prosperity**

PPFS Webinar on Sharing Best Practices on Digitalization and Innovation of APEC Food System

APEC Policy Partnership on Food Security

June 2022



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Economic Cooperation**

PPFS Webinar on Sharing Best Practices on Digitalization and Innovation of APEC Food System

Sharing Digital Innovation Technology Policies in APEC
Food System and Discussing Perspectives and Best
Practices for Next Steps of Roadmap Action

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APEC Policy Partnership on Food Security

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1. Introduction

Background

While the food security issue is becoming more critical due to the prolonged COVID-19 pandemic, the APEC Food Security Roadmap Towards 2030 was adopted which will serve as the goal of the APEC region's long-term food security and nutrition. It is time to bring about a shift to a sustainable food system of APEC member economies by pursuing economic, social, and environmental sustainability, and make joint efforts for the future of the APEC region where nobody is excluded. New digital technologies have the potential to improve food security and enhance agri-food trade by enabling more efficient and transparent agricultural value chains.

Korea hosted a webinar to share member economies' perspectives and best practices regarding the second action target, which will be led by Korea, 'Identifying and actively encouraging government schemes which provide access to and promote introduction of innovative products and technologies, including support for the research and development of emerging technologies such as smart agriculture, and share experiences of successful approaches taken in other economies and international bodies' of the action area of the Roadmap 2030, "Digitalization and Innovation".

It will contribute to the discussions on the implementation plan for faithful execution of the Roadmap through prior surveys and analysis and also focus on enlarging the understanding of different agri-food systems of member economies and identifying the most available policy schemes on this action target which each member economies could deliver.

Objectives

- i. To set plans that consider member economies' policy conditions including social, cultural, and geographical background, member economies will share policy priorities and implementation status, such as challenges of food systems of member economies that require utilization of digital innovation technologies including through surveys and promote the sharing of best practices.
- ii. Digital technology will expand policy-wide opportunities, such as cutting down administrative costs, by reducing the problems caused by information gaps and misaligned incentives. Identifying measures to promote policies implemented is necessary through peer learning opportunities and sharing success stories of member economies.

Key findings

The speakers indicated that the digital inclusiveness such as farmer's improved access to digital technologies in agricultural value chain with capacity building and infrastructure establishment is important for successful digital transformation and digitalized innovation in agriculture and food sector, which will contribute to lessening digital divide.

In addition, the government can play a key role in creating the environment for developing digital agricultural technologies. First of all, the government needs to identify related issues such as data privacy, security and ownership, evaluate the current regulatory framework in which digital technology is misused and its development is constrained, and then establish the relevant regulatory mechanism for

securing market competition, while avoiding concentration and incentivizing R&D investment in the private sector.

Another considerations made by the government is to facilitate policy coordination among different ministries including agriculture, water, land, environment, and technologies for successful digital transformation in agricultural value chain.

This webinar was specially designed to invite researchers and policy makers to share their experience and observation in establishing digital agriculture policies. Among them, 55% of webinar speakers and 51% of participants included women with extensive experience who will guide the discussions. To maximize the benefits of the project, members from the Policy Partnership on Food Security (PPFS) were also invited.

2. Webinar Proceedings

2.1. Digital connectivity and E-Agriculture for food security in Asia and the Pacific

Keynote speech: Ms Atsuko Okuda, International Telecommunication Union (ITU) Regional Office for Asia and the Pacific Bangkok, Thailand



Rural, Urban divide in digital connectivity

Ms Atsuko Okuda introduced a recently published ITU report, Facts and Figures 2021, which collects and analyzes data about digital technology and information and communication technology (ICT). This report illustrates a significant disparity in digital connectivity of the urban and rural areas. Globally, people in urban areas are twice more likely to have internet access, than those in rural areas, and when it comes to the least developed countries (LDC), this disparity becomes even worse), four times more likely to have the internet access in urban areas than in rural. She stressed that the digital inclusion is one of the top priorities to achieve the Sustainable Development Goals (SDGs), and to recover from COVID-19 faster.

As the food systems and agriculture will play a major role in achieving those goals, ITU has been cooperating with partners, i.e., including FAO, to guarantee that the digitization and digital innovations are implemented at every point of the value chain. This importance of ICT in different parts of the value chain is highlighted in ITU report¹. According to this report, the capacity development and access throughout the value chain, as well as in rural areas and remote communities, will be of paramount importance, especially in Asia and the Pacific. She pointed out that it will come with the need for data, enabling policy and approach from government level, with collaboration among different ministries and different agencies. She highlighted, in this endeavor, adopting ICT is crucial.

Role of ICTs in agriculture

ITU has been supporting different economies with different technologies and initiatives, from telephone to data, which lead to more advanced and emerging technologies such as blockchain, Internet of Things (IoT), big data, and artificial intelligence (AI). However, between the telephone and data, there are many important connection technologies in need: satellite, fiber optics, and mobile phones. In addition to that, data centers and digital platforms that will provide data to citizens, and the private sector are also necessary. In this regard, ITU works closely with FAO and other UN organizations to accelerate the digitization in the agricultural sector. More specifically, it has been working on the development of e-agriculture strategy, capacity development, the use of satellite imagery and geospatial information system (GIS) for agriculture. ITU has been assisting the economies from Afghanistan to Sri Lanka, and currently has a major project in Papua New Guinea, with the support of EU to look at the fishery. Various cultivation methods of crops, as well as the capacity development of not only the farmers but also businesses and the government, are in place to enhance and accelerate the digitization through different channels.

¹ FAO-ITU, (2016), E-agriculture Strategy Guide, Piloted in Asia-Pacific countries



Inter-sectoral linkages necessitate a whole-of-government approach.

According to Ms Atsuko Okuda, a secure and reliable government platform can serve as the building block connecting SDGs and the delivery of digital services to smart cities, smart village, and smart islands. For this platform, many software components will be needed, for example, messaging, procurement, and payment and these need to be executed by the ICT ministry in collaboration with other ministries such as agriculture. This will bring the economy of scale, as well as reduced investment costs, and this will also allow the interoperability and the exchange of data. For example, if a lot of data is needed from other ministries, the data transfer will be enabled through these building blocks. Therefore, ITU is now putting in place these digital building blocks, so that the services will be provided seamlessly and intelligently to end users in remote and rural areas.

Example of smart villages and islands

The initiative started from the previous satellite communication project that ITU implemented in the Pacific. ITU provided 9 economies with 93 units of satellite ground stations, so the remote islands were connected with the satellites. For the islands, the satellites became essential communication means when disaster hits the region. For instance, when the hurricane hit in 2020, the satellite ground stations were the only communication means when the economies tried to initiate the disaster response efforts during the Covid lockdown. Additionally, according to ITU’s assessment, this communication means were used by communities and remote and previously unconnected communities for education and health, and to provide and receive government services. From these experiences, the concept of smart Island has emerged. Through the whole-of-government approach as well as ICT, e-health, e-education, e-agriculture, e-governance, and all the government services will be provided with the advantage of low cost, scalable multi sectoral collaboration and partnership platforms in between. This initiative has been socialized among the Pacific Island economies. ITU received 10 requests from them to implement this initiative and received the funding from an UN SDG fund to be implemented next year.

The smart villages and smart islands have benefits as below:

- Reduced inequality, improved well-being, and access to better jobs thanks to digital services.
- Education, health, government, e-commerce service provided through a shared digital platform.

- Enhanced sustainability and cross-sectoral partnerships by adopting an SDG linked whole-of-government approach.
- Co-creation and scaling up of SMEs and businesses by providing a platform to help innovate their products and services.

Ms Atsuko Okuda highlighted that ITU is a specialized agency for ICT and has many different tools to support smart villages and smart islands, including the connectivity and digital services. On top of that, ITU has digital inclusion programs for people with disabilities or less school connectivity, as well as cyber security. In short, ITU is providing important integrated component to smart villages and smart islands.

Whole-of-government and digital agriculture

Ms Atsuko Okuda summarized the necessary whole-of-government, especially between ITU and agriculture ministries, approach for digitalizing agricultural into six categories.

Institution: Enhanced communication and coordination between entities using ICTs.

Infrastructure: Providing access to information resources, networks, digital services, and platforms to support policy decisions, better implementation, and innovative services.

Policies, Data & Information: Improved quality and timelines of data and availability for better decision making. Clear policies and guidelines on availability of data, its sharing and usage.

Digital Services: Improved access, financial and agricultural services, risk mitigation, disaster management, logistics, procurement, etc.

Processes and Mechanisms: Increased efficiency, compliance and monitoring using digital information systems and emerging technologies.

Capacity, Knowledge and Skills: Strengthened capacity on the use of relevant ICT tools/applications for better access to agriculture information and support.

She closed her speech by encouraging the policy makers in the ICT sector, industry, academia, and stakeholders in agriculture to participate in the global platform, World Telecommunication Development Conference, which is scheduled in June 2022 to create synergies of whole-of-government and whole-of-society approach.

2.2. Policy priorities for digitalization in agriculture: Implications for food system transformation

**Dr Suresh Babu, Head, Capacity Strengthening, International Food Policy Research Institute (IFPRI)
Extraordinary Professor, University of Pretoria, South Africa**

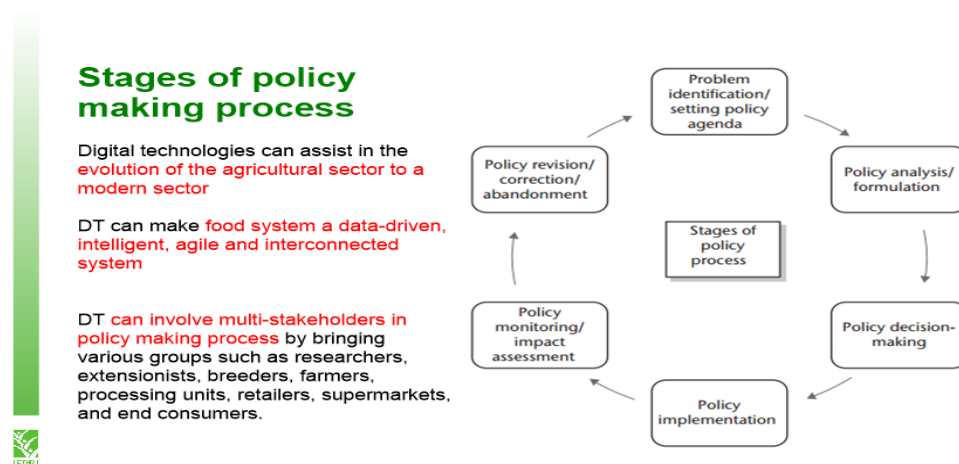


Policy priorities for Digitalization in Agriculture: Implications for Food System Transformation

Dr Suresh Babu provided the insight on the importance of inclusiveness in the transformation of the food systems as the follow up on the UN Food System Summit. He pointed out the role of the policy and that institutional mechanisms are as important as the technology development.

Importance of digitalization in policy making

He presented a diagram to facilitate the understanding in the food systems, noting that food systems transformation and agricultural transformation are interrelated. In this diagram, the 13 Sustainable Development Goals (SDGs) are directly and/or indirectly linked to the food systems. Therefore, in order to achieve the second SDG, namely food security and nutrition for all people, it is necessary to look at the availability of food accessibility and how food is utilized, and in this context, the political and institutional actions have become very important.



In the context of policy making, the digitalization of agriculture through ICT plays an important role in all aspects of policy making and policy analysis not only in terms of identifying the problem. For example, the digitalization helps policy makers by speeding up the identification of existing problems, such as identifying where the disaster happened, and providing correct data and evidence. It also helps policy analysis by providing a lot of big data, analyzing the spatial and temporal data which are indispensable for assessing the impact and the benefits of policy outcomes. The whole policy making process requires multi-stakeholders to be involved in, and through digitalization, combined data from different sources will interconnect them to make intelligent decisions.

Benefit from Digitalization of Agriculture

According to Dr Suresh Babu, the farmers face various problems starting from the production issues, and they can benefit from the information to correctly judge when and what to plant, and how to apply

correct amount of inputs and water, etc. On top of that, when considering the entire value chain, such as processing, value addition, marketing, and trade, it can also benefit from digitalization by connecting the value chains to local and international markets.

He highlighted that how can digitalization enhance the effectiveness and efficiency of food systems is an important question to be addressed. By answering that question, it will be possible to provide evidence for policy making where we often lack the adequate evidence. In order to guide the policy making on farmers' behalf, digitalization is very important.

Emerging Trends in Digitalization of Agriculture

Digitalization is not a newly emerging trend in the developing and emerging economies; several cases of digitalization have been happening for several years. One example is the mobile technology for financial transactions in Africa. For example, Kenya is far ahead in connecting farmers with financing that has been happening already. In the last two decades, global advances in precision agriculture, remote sensing, robots, farm management information systems, and computer-aided decision support systems have paved the way for broad digital transformations in the farming sector and in some of food value chains.

Also, recently developed techniques such as cloud computing, Internet of Things, Big Data, blockchains, drones, and artificial intelligence facilitate the integration of technology development into smart food production and service systems to ultimately enhance resilience. However, these versatile techniques require regulatory mechanisms as they can be a potential threat when misused. For example, drone is a useful tool for farmers, but it may be used with harmful purposes and there has not been adequate policy support for the use of drone technology in agriculture, particularly in the South Asian context.

Opportunities in Agricultural Digitalization

Digitalization of food value chains can improve resilience of agriculture and also the digitalization, such as sharing price of market information can reduce the price fluctuation, productivity fluctuation, and protect the farmers from vulnerability. As more vulnerable farmers are connected to global supply chains, digitalization is fundamental for them to take proper action. Digital innovations in agriculture can also increase the farmers output and its values up to several times, through online big data and genetic data. In that context, particularly on the productivity side, the policies for digital sequence information are needed, which can not only be helpful in technological revolution, but also in the social and environmental aspects.

Three policy areas need immediate action

Dr Suresh Babu highlighted three policy areas that are currently missing and require immediate action. First is the policy coordination that facilitates the adoption of digital transformation in food value chains. Food systems are not only related to agriculture, but also to land, water, irrigation, and health since the outcomes of the systems are reflected in human health. The second is providing regulatory and institutional environment for data management, data use, inclusiveness of data, openness of data, and data transparency. Finally, bringing in the interdisciplinary teams to work together in order to build not only the technological aspect of digitalization, but also social and environmental aspects of digitalization to benefit farmers as well as those involved in marketing, agriculture processing, trade, and even the consumers through the food systems.

2.3. Digital agriculture and sustainability: A review of the evidence and gaps

Professor Kelly Bronson, Canada Research Chair in Science & Society
University of Ottawa

Digital Agriculture and sustainability: a Review of the Evidence and Gaps

Professor Kelly Bronson elaborated on three topics in this speech. First, she defined digital or digitized agriculture, then presented the argument that links digitization to sustainability gains in the food production sector narrowly focusing on the production end of the food system or chain. Finally, she presented the results of a recent meta review of the literatures on the evidence and the gaps in the evidence linking digitization of food production to sustainability.



Definition of digital agriculture

In the paper of McBratney², the digital agriculture is defined as an “approach” to farming that uses data-based insights to drive farm decisions that uses digital tools from sensing embedded in equipment including precision agricultural equipment, for example, remote sensing from satellites or drone technology to GPS. At the center of this approach, there is data. The collection of data, and the aggregation of those data into big data sets that can be mined by sophisticated computing, which is expected to produce insights on farming. Digital agriculture defined this way is already being used not only in food production but across the entire supply chain. However, the adoption of these tools is notably uneven. In the Canadian context, small scale and incredibly biodiverse farms contribute very significantly on ecosystem services, both domestically and globally. From her research on those farmers, who have not adopted digital agricultural tools, shows that this is because the tools are designed for the large-scale farmers or commodity growers. They do not fit the conditions of small farmers and the cost of the tools is not affordable to those small farms.

Arguments linking digitization to sustainability gains

According to Professor Kelly Bronson, in Canada, one third of total greenhouse gas emissions are from food. The professor introduced some studies presenting meaningful sustainability gain through digitization of the chain. First, Weersink, et al. (2018)³ suggested that more food will be produced on less land, with fewer inputs and a smaller environmental footprint when technologies of other areas are applied to agriculture. Then she also introduced a study of Rossel and Bouma⁴ suggesting that the digital agricultural transformation is considered by some to be so profound that it could represent a “paradigm shift”. She also quoted that “Using soil sensors in agriculture can fundamentally change farming by allowing innovative ‘bottom-up’ approaches that characterize local soil and environmental conditions in space and time, improving the efficiency of production to maximize farm incomes and minimize environmental side effects.” However, she stressed we need the evidence that digitizing food production leads to sustainability gains.

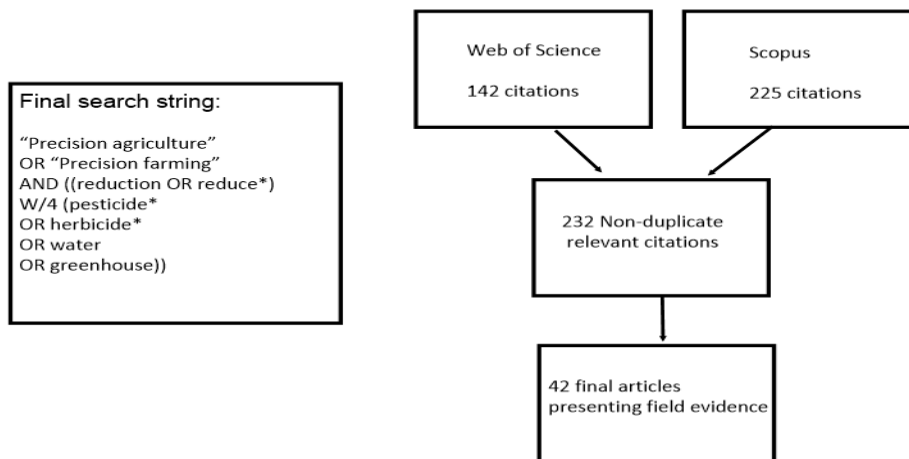
² McBratney, A. et al. (2005), *Future Directions of Precision Agriculture*, Precision Agriculture, 6, 7-23

³ Weersink, A. et al. (2018), *Opportunities and challenges for big data in agricultural and environmental analysis*. Ann. Rev. Resour. Econ. 10, 19-37

⁴ Rossel, Raphael A., and Johan Bouma. (2016), *Soil Sensing: A New Paradigm for Agriculture*. Agricultural Systems 148:71-74

Result of a metareview on the evidence and gaps

Professor Kelly Bronson briefly mentioned the result of her recent metareview work that she filtered 42 articles providing robust evidence of a link between sustainability gains and digitalization out of 400 articles in English, Spanish, and French language in total, mentioning reduction in pesticides, herbicide, water, and greenhouse gases. They present results mostly from field trials or experimental evidence including few of reliable predictive modeling.



She found a few interesting facts:

- Most articles measured sustainability gains indirectly.
- A few articles that have presented concrete evidence were focused on productivity as much as they were on sustainability.
- There was an evidence of reduction in fertilizer and pesticide use in particular by 23~26%.
- Most of the selected articles measure sustainability gain indirectly which is not incomplete, but insufficient.
- In addition to that, most articles have conducted a short-term field experiment during one growing season but not through a year; the long-term evidence is left unchecked.
- For a broad theme, a lot of the articles focused equally on productivity.

Understandably, the real emphasis in the literature so far, even that addresses sustainability in an experimental or evidential way, was put on productivity.

Urging supportive policy for investigating the link

Professor Kelly Bronson closed her speech noting that we still need more evidence about the sustainability gains from digitalization. Because of uneven adoption, it is difficult to get that proof easily, therefore she suggested a policy recommendation thinking of inclusive, innovation, and the SDGs, supporting right programs, in particular research programs that investigate this link through experimentation.

2.4. What's cooking: Digital transformation of the agrifood system

Dr Ghada Elabed, Senior Agriculture Economist Global Engagement Unit in the Agriculture and Food Global Practice, World Bank

What's Cooking: Digital Transformation of the Agrifood System

Dr Ghada Elabed introduced a World Bank publication, *What's Cooking: Digital Transformation of the Agrifood System*. This book was produced by a team from the Agriculture and Food global practice in support of several donors, including the Korean government through the Digital Development Partnership. In this book, she aims to show how the food system evolves rapidly due to the digital technologies, and she also describes the public policies ensuring these changes have positive impacts in terms of equity, environmental sustainability, and efficiency. She summarized these two points in this presentation.



Evolution of food systems with digital technologies

Dr Ghada Elabed emphasized that the current food system is not fit for the purpose of achieving the Sustainable Development Goals (SDGs) because it is pressuring the environment by generating the pollution, for example 39% of the GHG emissions, while it is sustaining the world's ever-growing population and creating millions of jobs. Also, the food system now is flawed by producing abundance of food while leaving the undernourished worldwide. Therefore, it is yet to achieve its objectives. She suggested two feasible solutions.

She illustrated that the food systems are complex. There are 570 million farms with close to 7.5 billion consumers, located globally. The farmers are connected to thousands of upstream and downstream actors and markets which means millions of connections are needed be in place between the different actors to bring food to the table. Another key issue she made clear about the food systems was the transaction costs. To unlock the potential of the food systems, the transaction costs issues should be addressed. These transactions are all over the food systems. They are encouraged by farmers, their business partners to find each other, make deals and ensure that these deals are enforced. While the transactions being essential to the production of goods, the costs following them drive farmers to choose quantity over quality at the expense of the environment, which ultimately affect consumers product choices.

In this context, she pointed out that digital technologies are promising. They can reduce this transaction costs and help the agri-food system overcome the obstacles and deliver on its objectives. The digital revolution is considered different from the other revolutions that have originated in the agricultural sector because it is starting at every point of the value chain; There are changes on the farm itself, and also upstream and downstream of the farm. Whereas for the example of the Green Revolution, it is mainly started on farm with higher yield varieties.

While Dr Ghada Elabed left how the digital technologies can solve some of the earlier issues that we encounter in the food systems for the book to say, she highlighted benefits and risks of digitalization. One of the key benefits of data understood technologies is increasing market efficiency in the value chain. For example, digital e-commerce platforms allow farmers to access multiple markets and obtain better prices for their production. Another benefit is that the digital agriculture can improve equity, for example, through inclusion of smallholder farmers, women, and marginalized populations. Lastly, the digital technologies could increase environmental sustainability by reducing food waste, resource

management, and rewarding environmentally friendly practices, although we lack clear evidence, as demonstrated by Professor Kelly Bronson. The benefits are great but there are also some risks.

The key risk is lack of competition. There are concerns that digital markets will increase market power and filter profits to few digital technology providers. The second risk is the digital divide, meaning that some people may not access the technologies or have sufficient internet connection and don't know how to use the technology. Also, there is a new social risk that emerges with digital technology caused by the misuse of data. The important questions are who gets to use and control the data collected by all these digital platforms, what do they do with this data and how do they ensure the privacy of consumers. For farmers, this is a big concern because they provide both their personal data, as well as their business data when they use digital platforms such as e-extension and e-inputs. Additionally, another challenge is related to environmental impacts, the rebound effect from over exploiting the natural resources.

Policy framework for fostering efficient, equitable and environmentally sustainable digital transformation of the agrifood system

Dr Ghada Elabed introduced two tiers of public policy interventions, through which we benefit from digital technology and mitigate the risks. The first tier contains three foundational enablers that are preconditions for a digital transformation. They are the digital infrastructure such as phone and internet. Most of the time these are provided by the private sector, but in some cases, it makes sense to be provided by the public sector.

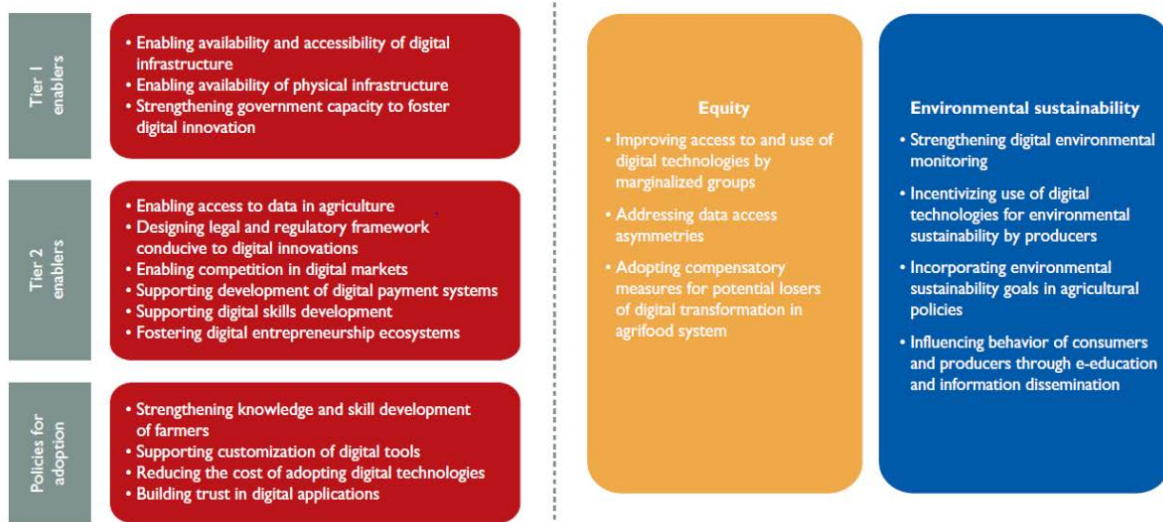
Tier I

- Enabling availability and accessibility of digital infrastructure.
- Enabling availability of physical infrastructure.
- Strengthening government capacity to foster digital innovation.

The second tier includes the policies needed to support an innovation ecosystem for digital agriculture. These will strengthen the access to foundational data, promote data sharing, and safeguard farmers' data privacy, security, and ownership.

Tier II

- Enabling access to data in agriculture.
- Designing legal and regulatory framework conducive to digital innovations.
- Enabling competition in digital markets.
- Supporting development of digital payment systems.
- Supporting digital skills development.
- Fostering digital entrepreneurship ecosystems.



She closed her speech with summarizing three key messages. First, the data driven digital agriculture is about data and the new capacity to create, transform, and analyze this data to generate insights. Second, there are many risks along the way of this digital transformation, including data privacy issues and exacerbation of existing inequalities. Third, this digital revolution will have to be led by the private sector, but to maximize the benefit and minimize the risks, the public sector has to set the rules of the game and provide the right incentives for the private sector.

2.5. Panel discussion and Q&A

Moderator: Jang Heo, Research Director, Center for International Partnership, Korea Rural Economic Institute

Q1: “What are the examples of this technology and connectivity initiatives which support the food system in Asia and the Pacific?”

(Ms Atsuko Okuda): A simple example which has been very popular across Asia Pacific, is to digitize the intermediary part which helps the farmers get to the market and sell their produce with a better price. In some economies, there are digital platforms that collect the information and the produce from farmers and connect them quicker with the buyers in the capital, or bigger cities. This comes with the arrangement of the logistics. These intermediary services are immensely helpful because if each farmer has to find the information, as well as buyers and market or market conditions themselves, that will take a lot of time and effort.

Such aggregation of market information and access to it would be immensely helpful and creates significant efficiency between farmers and buyers. Another example is the information on natural disasters, as well as weather forecast, which is linked to the insurance. In some economies, there were experiments using the blockchain to automate the insurance payment. For example, if the contract is set to make the payments, under the extreme weather, and if these parameters are met, the blockchain will automatically process the payment in a transparent and secure manner.

Q2: “How digitalization could help in productivity challenges faced by production systems. What can you suggest on this one?”

(Dr Suresh Babu): At the global level, the evidence is bringing global knowledge together for how we can achieve the SDGs, for example, through food system transformation. However, all these things have to happen at the farm level, at the community level. If the action is not at the farm and community level, you might have all the policies you want, but things will not change. So, in order to get the answer to this question and to address the productivity challenges, the basic fundamental information for how to decide what to grow in terms of addressing the subsistence needs to some extent. The smallholder farmers were left behind, not only in the digitalization wave, but also even in the previous technological wave.

In addition to that, the institutional effort should be strengthened to avoid digital information divide. The research and innovation systems in the developing economies need to be directly connected to the farmers in order to guide them in identifying the optimal crops that they can grow. At the same time, not only the nutritional needs but also the sustainability issues have to be met, for example, climate smart agriculture. To promote climate smart agriculture, it is required to connect the data, convert that data into information, then convert the information into skills that farmers can use effectively to change the farming systems, or to address, and build the resilience of the farming systems. This link is tightened through capacity strengthening and skill building.

Also, the access to information and technology in the digitalization context is fundamental, and we will be leaving a huge group of farmers behind, once again, in the digitalization. The productivity is also fundamental, and that's where precision technology comes in. These require connecting the farmers not only through the traditional technological route, but also through the modern technological route which is digitalization through information sharing and making the information access to them, right on the farms through the applications and so on.

Even though many applications coming in, they are not organized nor coordinated, and the extension system needs to be reformed so that they can actually use the knowledge base through the technology digitalization and then share it with farmers. It also reduces the amount of investment caused by physical presence of extension workers if we can do the digitalization much better. That's where the productivity challenges and production system challenges can be addressed at the local level, at the farm level, and even at the landscape level.

Q3: “What policy is needed to facilitate the digital revolution in agriculture?”

(Professor Kelly Bronson): There is a separate set of policies needed to facilitate transformation and agriculture, led by digital tools, and an inclusive digital revolution. To mention about the first, if we look at the Canadian context or Australian context for example, the main barriers to adoption and to allowing a full scale or fully realized smart farm are the kind of infrastructural or classic digital divide issues that some of my fellow panelists have talked about. Broadband access is now inadequate in digital infrastructure, so I think the public sector or policy makers have a role to play in developing that infrastructure.

There's a lot of movement in Canada at least to do that. There are classic digital divide issues which are not just lack of access to adequate broadband, for example, to have a fully connected IoT farm, but also lack of digital skill or comfort with these technologies. The average age of farmers in Canada is 56 and many farmers report digital skill is an issue with them, as a barrier to adoption of digital agricultural tools. Those are some of the low hanging policy implements or leavers that could be pulled to drive a digital agricultural revolution, at least in this context. However, an inclusive revolution is different. We think of smallholder farmers and peasant farmers in the global south, being potentially left behind through this technology lead food systems transformation, starting with the Green Revolution, arguably the biotech revolution and now digital agriculture.

We think of issues of cost around these technologies as one barrier to adoption among that scale or type of farmer. However, actually this is not just a problem in the global south. Small-scale family farmers in Canada and in the US are also being left behind in these contexts. If we think this transformation is inevitable, we need to generate technology-led transformation more inclusive. Globally peasant farmers or small-scale farmers in the global northern context, are really important for food system resilience, for community food sovereignty, but also for right carbon sequestration through biodiversity gains, etc. It's not just a social justice issue but also about sustainability. There is a separate set of policies for driving an inclusive revolution. Public sector has an important role to play in regulating the collection of data and putting pressure on the private sector to open those data for food and nutrition, and science. -If we think about the gaps in the innovation ecosystems that have been left in these food system transformations, starting with the Green Revolution, the public sector has a role to play in innovating these markets that aren't attended to by the private sector simply because they don't make money. The private sector-driven innovation, perhaps innovation driven in a local context as Dr Babu said, that's maybe one policy solution to an inclusive digital agricultural revolution.

Q4: “You mentioned, seven no regret policies at the end of your presentation to enable the digital transformation of the food system. Could you provide some more details about these policies?”

(Dr Ghada Elabed): The World Bank work with the public sector and definitely the public sector has a fundamental role to play in the digital revolution. As presented earlier, we identified seven no regret policies. These would definitely be implemented by the public sector.

The first one is to ensure that all the actors have access to fund the foundation of data. Let's think, for example, of agriculture insurance, which is a private initiative. Traditionally, farmers, especially smallholder farmers are excluded from insurance markets because of several reasons and freely available satellite data can allow entrepreneurs to design products that are affordable and suit the needs of farmers. Therefore, ensuring that entrepreneurs have access to this data is a very important role of the public sector.

The second fundamental role of the public sector is to ensure data privacy, data ownership and security. These are new risks that arise with digital technologies. Even in the US and Europe, they're still struggling and exploring solution to this problem. Europe has a lot of experience with this area which will help other economies. This issue becomes even more important when we think of the value of data. A single piece of information provided by a farmer is not very valuable perhaps, but when you aggregate this information for many farmers and consumers who give their information and exchange the use of a technology, that data become valuable. It becomes an important issue.

The third one is about reviewing the regulations that constrain the use of precision technologies like a drone, for example. Another role of the public sector is to ensure competition of digital markets and avoid market concentration. The role here is to make sure that data and technologies and standards are inter-operable. This would allow us to combine data generated on farm with data from multiple sources, for example, the government could encourage interoperability between mobile operators and financial institutions to improve the financial inclusion of smallholder farmers.

We have the fifth recommendation which is digital payment system. A lot of digital platforms like Amazon and Jumia rely on digital payments, so it is important for the government to put these digital systems in place, and also create a system that is trustworthy, by all the parties. The sixth is scaling up the innovation ecosystem. The private sector is going to innovate, but they need an innovation ecosystem to thrive. There's a need for the right agricultural policies, for example, startup policies and regulatory sand boxes.

Digital entrepreneurship is going to be a key driver behind the supply of the solutions, but the government and the private sector are key to encouraging the startup phase of this technology, by providing, for example, seed funding, or organizing innovation challenges like what the World Bank has been doing in many economies. The seventh is an important role of fundamental research and other research. There is a lot of evidence on the return to research agriculture and the government and the public sector could support financially the research sector. These are the seven key areas we think are the focus of the public sector.

Q5: “What are the core elements to be considered, and the policy direction for the implementation plan of digitalization and innovation action area of the roadmap 2030 which will be established by APEC PPFS next year?”

(Ms Atsuko Okuda): The most important core element to be considered for policy direction is a whole-of-government approach. There are many foundational building blocks which are already being put in place across Asia and the Pacific. I believe that the Ministry of Agriculture, as well as the stakeholders in the food systems will be able to take advantage of such systems, and that includes the data and

services, such as procurement and financial payments with the government, between government and non-governmental entities.

The importance of cyber security is also emerging in this context. The ICT ministry, as well as the agency responsible for infrastructure and services are also looking after the security aspect of these infrastructure and applications. The food system stakeholders, and the ministry colleagues will also be able to benefit from cyber security measures and initiatives which are being rolled out by the ICT ministry. These could be considered for the finalization and implementation of the Roadmap 2030.

(Dr Suresh Babu): From the policy perspective, we are facing a major challenge in terms of bringing the multi-sectoral nature of the problem. Digitization cuts across several sectors, particularly in the food systems. How do we build the policy analysis and strategy development capacity? We often find most of the reports coming from international organizations like our institute or the World Bank, but we do not have that capacity at the national level, to think about what the strategies they should be thinking about even in the Asian context, although the capacity level is higher there. How do we build the policy system capacity to think through, what kind of digitalization is needed, and how can that digitalization happens in terms of appropriately designing interventions and implementation of programs? That's one broad area.

The second area is regulatory systems. How do we design the regulatory systems which guarantee transparency in data, collection of the data, and use of the data, particularly for everybody to use openly? How can we get that regulatory system in place? The economies themselves will not be able to develop that strategy and regulatory mechanisms for implementing.

The third aspect is the individual capacity at the national local landscape, farm-level digital divide, coming from the capacity of the farmers to use the information even if they have a cell phone. If they do not use that information effectively, then there is going to be a major challenge in transformation of food systems. The capacity at all levels—from the policy, institutional and individual levels—are major constraints. That concern is to be addressed through tracking, monitoring, and evaluating the progress we are making. Also generating the evidence on what impact that digitalization can make on the food systems transformation is also important.

(Professor Kelly Bronson): A set of principles actually in the realization of digitization would be good as a kind of guidance element across policy domains and to get out of sight the kind of siloed thinking that Dr Babu was talking about. Inclusivity is one important principle that could be used to drive digitalization.

Thinking about digitizing for a diversity, a variety of perspectives and concerns of stakeholders are taken into consideration through the innovation and the regulatory processes. However, other principles too might be important to drive or to steer the car on the road. When thinking about the realization of this or implementation of the roadmap, other principles are transparency, for example, especially if they're collected by and then become part of the corporate domain. For example, through the collection of data by precision tractors, making data sets, but also algorithms that was driven by the decisions is less opaque.

Open international agricultural or nutrition research legibility has to be a principal; not just opening data sets to researchers who might be interested in contributing to achieving SDGs, but also to farmers who helped collecting those data. Legibility as a principal, and then appropriateness and inclusion, the

transformation is being driven by private sector and the technologies therefore are appropriate to only certain farm environments and they are farmers who represent a significant market for the private sector.

What about all of the farmers who don't represent that significant market? They are going to be left behind and is there a way to think about not scaling down the expensive technologies but actually coming up with local solutions through public sector support. Starting from a kind of local perspective as opposed to a set of seemingly universal technologies that are developed by international or transnational corporations is key here and policy supports for that in the implementation of digital agriculture is also important.

(Dr Ghada Elabed): The key takeaways from our work with this digital agriculture report is that non-digital enablers are critical. We still need to invest in better connectivity to avoid the digital divide and leaving smallholder farmers behind. Also, we need to get creative in getting the public and private sector to work together, collect data, and connect stakeholders through public and private partnerships. A good principle would be to get the regulatory environment on data governance, given the risks of data misuse and also to make sure that there is enough competition.

There is an issue of how to deal with an innovator, who needs to access data, while data property is preserved, and information of farmers is not compromised. The government can make better use of data for decision making, but this requires investment in capacity building and data systems. That would be an important element of operation analyzing the strategy. The government does not have to start from scratch. They can rely on information already collected from satellites for decision making. For example, soil maps and early warning systems are all relying on already freely available satellite information and analytics that can inform governments. The Minister of Agriculture could hire new profiles of staff who are experts in digital agriculture and who could support their own public service delivery and the design of strategies that are digitally informed. Also, the government could collect additional data to help them better target their interventions and spending, etc.

Finally, there is a need to consider the specificity of the agricultural sector and find solutions to fill the financing gap for innovation in this area. An element of the strategy could be focused on bridging the financing gap. For innovation in this area, it is an excellent document I enjoyed reading it. It acknowledges the complexities of the food systems and proposes a holistic approach to reach the objectives of achieving an open, fair, transparent, productive, and sustainable APEC food system.

Q6: “[From Chinese Taipei] Since the majority of farms in APEC is smallholder farmers, what are the challenges and strategies to help these small farmers to adapt to digital technologies?”

(Ms Atsuko Okuda): As mentioned earlier, which is smart village and smart islands. This initiative aims to do a community-level needs assessment and conduct the digital literacy skills development. Now, this is very important because digital skills are needed, not only as a farmer. Since an individual plays a different role in society, he or she could be a community leader. He or she could be a learner, or a teacher at the same time. I believe that the digital skills development is applicable, not only in the sector of agriculture but in education and health.

This cross-sectoral collaboration, and the whole-of-government approach would be very effective. This would be needed to conduct the essential functions in increasingly connected digital world. What I would like to suggest is that, especially for those communities, which are remote, isolated, and unconnected when the connectivity is extended, there will be a collaboration between the Ministries of

Education, Health, agriculture, ICT, and commerce to join hands, and to provide such digital literacy and skills development that will help the farmers be able to operate and use, access and benefit from digital applications and services, which are made available by that capital, as well as the private sector companies and NGOs to support different aspects of their work.

Such initiatives to aggregate the demand and the digital services to be provided to the community as a whole will be essential and will be found useful. Connectivity expansion in remote and rural areas is also required. However, according to the ITU statistics, which was released yesterday, we see a significant acceleration of this effort because of COVID-19. We have seen a massive, and accelerated expansion of network coverage. The number of broadband subscribers, and there are more digital services, made available to cyberspace. We can capitalize on this momentum, and be able to collaborate, and perhaps create synergies with different sectors across society, and I hope that this meeting will provide such stimulating conversation and partnership to move to, co-creation and synergies across the sectors.

(Dr Suresh Babu): What we need to think about is how we assess the information needs of the farmer, that itself is a major gap right now. How do we assess the capacity needs of the farmers, and then context specific and locally relevant type of interventions that will require use of the data, converting the data into information that is beneficial to the farmers? That's the only way we can help the farmers use the digitalization not just giving a cell phone or iPad. You have to have the information that is easily accessible, locally relevant and context specific, then it will be useful for solving the farmer's problem.

2.6. Digital tools for enhancing resilience in the wake of COVID-19

Dr Lee Ann Jackson, Head of the Agro-Food Trade and Markets Division in the Trade and Agriculture Directorate (TAD) at the OECD



Digital Tools for Enhancing Resilience in the Wake of COVID-19

Dr Lee Ann Jackson gave an overview of some of the recent work carried out by the Agro-food Trade and Markets division in OECD on food systems including in relation to digital tools.

Call for better policies for food systems

She introduced a report published by her team in the beginning of 2021. This report highlights that food systems were facing a daunting triple challenge such as food security and nutrition, livelihoods, environmental sustainability, even before the COVID-19 pandemic. We expect agro-food systems to provide food security and nutrition for growing world's population and livelihoods including for the farmers and other stakeholders along the value chain in an environmentally sustainable way. During the COVID-19 period, the food systems are expected to be resilient. Food systems have made important achievements, but also have contributed to environmental harm such as greenhouse gas emissions and loss of biodiversity. In addition, globally about 2 billion people do not have regular access to sufficient, safe and nutritious food. Then she highlighted that better policies could make a difference, and this is where the OECD work can inform policy makers, including the work carried out by the Agro-food Trade and Markets Division, as well as work in other parts of the OECD.

SPS electronic certification enhanced trade

In a report on digital opportunities for sanitary and phytosanitary systems, it was clear that digital SPS technologies are changing through the use of electronic certificates. These technologies can benefit us with increased security, reduced processing time, faster flow of data, greater equity, and inclusion. The report shows the trade is much improved by the rapid adoption of e-certificates. However, e-certificates in animal products seem to be not fully activated and there is a delayed adoption of the technologies. Therefore, her team is planning to work on electronic sanitary certificates for trading animal products and also on remote auditing and verification.

Benefits of Digital tools on food system

Dr Lee Ann Jackson highlighted that these tools provide important opportunities in terms of improving the flow of information to households, including through the adoption of QR codes that consumers can use to get more information about the products they are to choose. Also, she noted that the tools are not only useful for policy designing and evaluation, but also for food consumption data collection and aggregation. For example, we can make healthier food choices and better nutritional and dietary outcomes for populations.

Other work by her team highlighted that the digital tools help understand and address food insecurity through three broad areas: **data collection and analysis** through web-based surveys or web-based mapping tools; **targeting policy interventions** such as e-vouchers for low-income families; and **policy design and evaluation** on how policies work.

How to have better policies for food systems

Dr Lee Ann Jackson pointed out that we can make better policies by overcoming evidence gaps. However, in order to ensure that evidence exists to support better policies we need to overcome the following challenges:

- Evidence is often incomplete.
- Different data sources may use inconsistent methodologies.
- Evidence particularly lacking on synergies and trade-offs across different aspects of food systems.
- Evidence is often not detailed enough. Evidence may be fragmented across different actors.

Better policies for food systems will require overcoming evidence gaps

| | | | |
|--|--|--|---|
|  | <ul style="list-style-type: none"> • Evidence is often incomplete - e.g. <i>low reporting rates for SDG indicators</i> |  | <ul style="list-style-type: none"> • Evidence is often not detailed enough – e.g. <i>not segmented by socio-economic status</i> |
|  | <ul style="list-style-type: none"> • Different data sources may use inconsistent methodologies |  | <ul style="list-style-type: none"> • Evidence may be fragmented across different actors - e.g. <i>private/public</i> |
|  | <ul style="list-style-type: none"> • Evidence particularly lacking on synergies and trade-offs across different aspects of food systems... |  | <ul style="list-style-type: none"> • ... and on policy effectiveness (what works) |
| A pragmatic way forward... | <ul style="list-style-type: none"> • Prioritising needs (e.g. using evidence gap maps) • New technologies (e.g. earth observation data, apps) • Consider institutional innovation (e.g. CDP: voluntary disclosure for firms) • Avoid reinventing the wheel (e.g. modify existing farm surveys to include sustainability) | | |

Source: OECD (2021) Overcoming Evidence Gaps on Food Systems.

Evidence is often incomplete, for example, we don't have great reporting rates for the SDGs. Sometimes we have different data sources that use inconsistent methodologies and evidence may be fragmented. Especially around food systems, evidence is lacking in terms of evaluating synergies and trade-offs across policies that are seeking to achieve these triple challenges of improving food and nutritional outcomes and livelihoods in a sustainable manner. Also from the OECD perspective, it has been noted that there are evidence gaps in relation to policy effectiveness—what policy works and what makes a policy effective. Hence, it is necessary to help policymakers make better choices by taking advantage of new technologies, and to avoid reinventing the wheel and wasting resources that could be better used in other areas.

Dr Lee Ann Jackson closed her speech with delivering that there are lots of expertise and reports on food systems⁵ at the OECD and they will be helpful for overcoming the abovementioned obstacles.

⁵ OECD, (2021), Making Better Policies for Food Systems
 OECD, (2021), OECD-FAO Agricultural Outlook 2021-2030
 OECD, (2021), Agricultural Policy Monitoring and Evaluation 2021
 OECD, (2021), Overcoming Evidence Gaps on Food Systems, 2021
 OECD, (2021), Building Agricultural Resilience to Natural Hazard-induced Disasters
 OECD, (2020), OECD Review of Fisheries 2020
 OECD, (2019), Innovation, Productivity and Sustainability in Food and Agriculture
 OECD, (2019), Trends and Drivers of Agri-environmental Performance in OECD Countries

2.7. Case study of digitalization for food loss and waste and aquaculture industry in Singapore

Mr Matthew Tan, Co- Chair for Sustainable Development in Agriculture & Fishery Sectors APEC Policy Partnership on Food Security

**Chief Executive Officer, Asia Assentoft Aqua Pte Ltd
Case Study of Digitalization for Food Loss and Waste and Aquaculture Industry in Singapore**



Professor Matthew Tan introduced the case study of digitalization of food loss and waste and aquaculture industry of Singapore. He expects that the utilization of digitalization to manage food loss and waste in the hospitality industry in Singapore can significantly benefit the food system, and in the end, they will be able to align the result with the APEC Food Security Roadmap towards 2030.

Circular Economy in Singapore

In Singapore, the circular economy approach is adopted; people consume locally grown food in a regenerative way. Expertise is being established in the R&D system where food byproducts can be transformed into an array of valuable materials. Besides, many players from different stages of the food supply chain are collaborating for food loss reduction.

The Circular Economy

Circular economy requires data measurement

1. Starting with Prevention
2. Prevention is only possible when we have the knowledge on the waste
3. With knowledge, you can then have follow-up practices:
 - Reduce
 - Reuse
 - Recover
 - Recycle
 - Disposal



This circular economy starts from reducing waste and it requires data management to pinpoint where the waste is generated. Blockchain is adopted to trace food safety and reduce food loss throughout the food supply chain, and AI is used in data insights for cost reduction and waste prevention. Besides, embedded systems are used for water metering and energy consumption.

Case 1: Hotel (Hospitality)

Hotel was exploring on solution to comply with the Resource Sustainability Act (RSA) which will be mandatory segregation and reporting by 2024. The objective is to achieve zero waste and reduce the cost by reducing food waste. However, the hotel does not have sufficient data to identify where in their estate the waste is mostly produced. It is now in phase 1, collecting the data and finding which contributes the most to the waste.

Case 2: Medical (Hospital)

Hospital was exploring on solutions to reduce the overall food waste, which would result in reduction in operating costs, and more importantly, to comply with the ESG standard. They are currently using the hardware to capture data on the type, amount of waste and reason for the loss. However, they did not have any means to analyze the data acquired. The phase 1 for this project was to analyze the data, identify the gaps, set end outcomes with corresponding measures, and analyze the results from implementation. After completing phase 1, they moved on to phase 2. They donated or repurposed reusable food, and for those that cannot be reused, they sent them to the dumpster. In every step of this process, information including the amount and date were recorded with blockchain technology.

The final phase of food waste solution moves upstream to the breeder. All the food loss and waste happening within the food supply chain will be traced with blockchain with the expected operation cost reduction of about 30%. The result will follow the RSA and the ESG standards.

Digitalization of aquaculture industry

Key challenges in aquaculture are as follows:

- Water quality: lack of early warning system or water quality management.
- Growth stages: different stages require different water quality parameters.
- Species: different species require different water quality parameters.
- Mortality risk: lack of real time data to react.
- Yield optimization: no proper water quality data for yield optimization.

There are many applications and IoT or AI solutions but often they lack expert consultancy, informing the users what they need. He introduced Energetix™ aquaculture, which is a package solution expert consultants come in and pinpoint the problems.

2.8. The Provincial Crop Calendar of Food Security and Nutrition

Ms Pasinee Napombejra, Senior Policy and Plan Analyst, Office of Agricultural Economics (OAE), Ministry of Agriculture and Cooperatives of Thailand

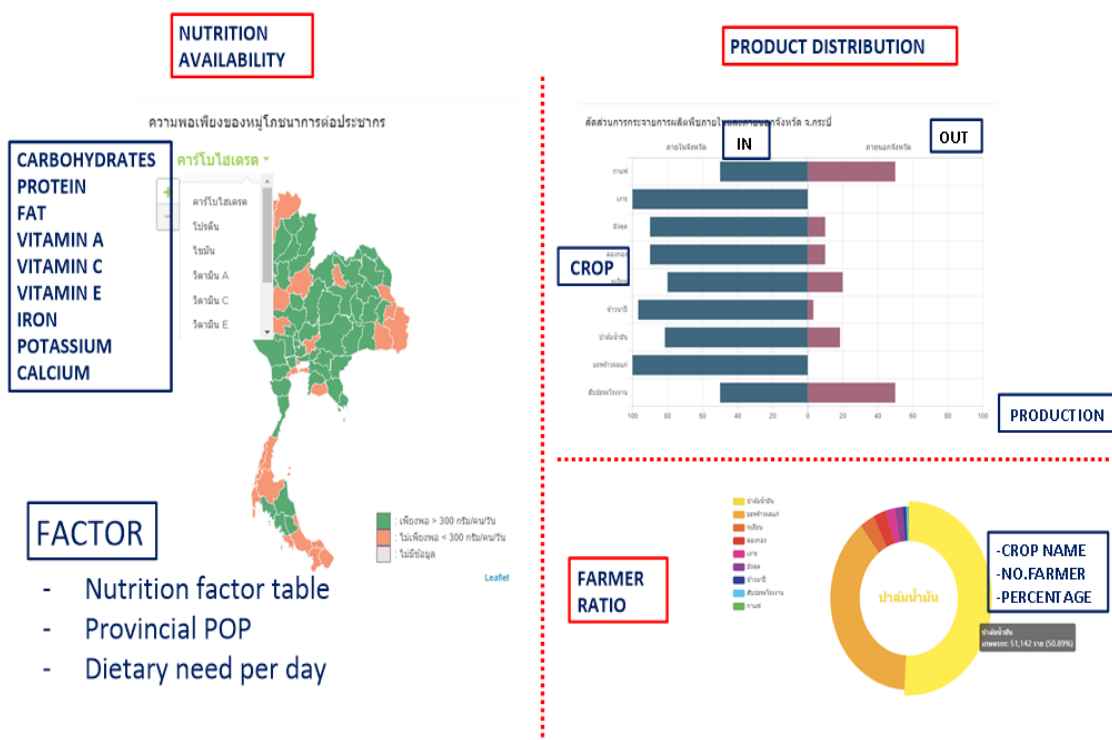


The provincial crop calendar of Food Security and Nutrition

Ms Pasinee Napombejra introduced the provincial crop calendar for food security and nutrition in Thailand. The Office of Agricultural Economics (OAE) has the mission to recommend agricultural and cooperative policies, measures, and plans, as well as properly administering and disseminating agricultural information to prepare Thailand’s agriculture for competition in the international markets, and for greater farmer’s quality of life. The OAE has been collecting data and providing it for major commodities. However, this is why these data cannot be used for the policy intervention at the local level, especially for food security and nutrition, so collection of agricultural data at this sub-district level is necessary.

Demonstration of crop calendar use

The collected data at sub-district level is now uploaded to a platform and available online. Ms Pasinee Napombejra demonstrated the function manual, in this crop calendar. It includes three sectors: plant, livestock, and fishery, and for each sector, information on crop production, crop yield, and nutrition availability is available.



For the crop production, area-based and time-based information are available. In case of the crop-based information, when selecting the commodity, rice, then the province, then the map of the province will pop up. When clicking the district, the map of the district will pop up as well. For the time-based information, monthly basis information is uploaded in the platform. These data will help the governor know that they can manage the production of each month.

For the nutrition availability, the platform provides data on production of the produce which is converted into the energy, and nutrition, for example, carbohydrates, protein, and fat, and also the vitamin A, C, E, and then iron, potassium, and calcium. You can see nutrition availability in the map in colors.

In conclusion, the provincial crop calendar is a digital tool that the governor and other stakeholders in the local area can benefit from the data. They can conduct the distribution plan for agricultural production, especially at concentration harvesting time. They can promote the crops that help improve nutrition as each province can identify what kind of nutrition that they lack, and then they can analyze agricultural economic situation at the provincial and regional level. They can also support the SDGs indicators of SDG2 zero hunger while providing agricultural big data for Ministry of Agriculture and Cooperatives.

2.9. Policy direction in smart agriculture of Korea

**Mr Dae-yeol Yoo, Deputy director Agro Industry Policy Division
Ministry of Agriculture, Food and Rural Affairs**



Policy Direction on Smart Agriculture of Korea

Mr Dae-yeol Yoo introduced the policy direction on smart agriculture of Korea in his speech. The agriculture in Korea is faced with reducing rural population, and aging population. The agricultural land area has been decreasing and the climate change is also stressing the Korean agriculture.

Supporting young farmers

To cope with the aging population and climate change, the Korean government is making efforts to disseminate smart agriculture. When utilizing IoT and big data, smart agriculture can promote productivity and reduce labour demand through optimized growing environment and automatic control system. To promote smart agriculture, the Korean government has been implementing related policies in four directions. The first policy is to support young farmers. Start-up incubation centers are in operation, providing 20-month education program to the youths. The well-performed graduates are provided with basic lease-type smart farm. Moreover, the government guarantees loan for farmers and provides overall support such as funds and land lease. The support also includes provision of smart agriculture equipment, such as sensors and automatic control systems, and real-time farming support services based on big data.

Building smart agriculture infrastructure

The second policy is to build smart agriculture infrastructure to facilitate the development of convergence and fundamental technologies of smart agriculture. The relevant Ministries have come together to pursue long term R&D projects. The goal is to go beyond the current mechanization and automation, and advance to technologies such as big data, AI and unmanned automation. Investment in R&D has been expanded to ensure fully autonomous greenhouse control, AI-based livestock farming, and farming techniques based on automation and robots. To build a ground for the utilization of agricultural data, Korea has been preparing the data standards and expanding the data collection. The collected data are accumulated in the agricultural data cloud, to provide support for the development of farming support services of enterprises. The government also plans to support the development and demonstration of technologies and products of businesses by establishing smart farm demonstration complex. To support the expansion of the smart farm model to overseas, the Korean government has established smart farm demonstration greenhouses in Kazakhstan and Viet Nam and are making efforts to strengthen international cooperation through ODA projects.

Developing leading models of smart agriculture

Thirdly, the Korean government is developing leading models of smart agriculture. As part of this effort, the government has been building four smart farm innovation valleys nationwide to foster young farmers and support farming businesses. Each Valley has an area of around 10ha, and includes Youth Business Incubation Center, test bed and lease-type smart farms. The complexes will serve as a base for the expansion of smart farms with functions such as incubation, business support and production integrated.



Aerial View of smart farm innovation valley

Furthermore, the government has been implementing an open field smart farm pilot project in main production area of major crops. For this, ICT irrigation, fertilizer, as well as advanced machinery are supplied, and a foundation for a data-driven farming is under development. Also, the pilot complex for the demonstration of unmanned use of advanced farming machine, such as IoT, autonomous driving, drone, and robots. The mid- and small-sized livestock facilities are transferred to Smart Livestock ICT Demonstration Complex, which is under construction.

Implementation system

The last policy direction is to enhance legal framework. To support policies for the promotion of smart farms in a systematic manner, the government is working on the enactment of the basic law, the Act on Fostering and Supporting Smart Agriculture. The law covers a wide range, including data utilization, development of infrastructure, human resources development and relaxation of regulation. Policies related to smart agriculture would be implemented effectively based on the law.

3. Main Takeaways

The agriculture changed from the labor-intensive type to land-intensive and capital-intensive type, and now it is turning into the idea-intensive agriculture. At the same time, we are facing the beginning of the fourth industrial revolution. To be in line with this change, it is necessary to broaden the concept of agriculture. New technologies are needed to expand the digital agriculture along with appropriate policies to promote the change. Eight presentations including three case studies gave us insights on the necessity of the digitalization of agriculture, and the urgency of promoting relevant policies.

Ms Atsuko Okuda highlighted the importance of information and communication technologies in achieving SDGs, and role of ICT in this progress. She claimed that to deliver digital services to every part of the society, the whole-of-government approach is essential. She suggested a platform as an inter-sectoral linkage between different ministries of government to facilitate this approach.

Dr Suresh Babu advocated the importance of policy in digitalization of agriculture. He highlighted three policy areas need to take immediate actions: policy coordination that accelerates the digital transformations of food value chains, regulation in transparent data use, and building interdisciplinary teams for social and environmental aspects of digitalization. Through these policies, he says the digitalization will benefit not only the farmers, but everyone including consumers through the food systems.

Professor Kelly Bronson introduced the review on evidence and gaps in linking the digitalization and sustainability. She believes that we still need more concrete and preferentially experimental evidence on the sustainability gains from digitalization. Because of uneven adoption of digitalization, the proof cannot be obtained simply, therefore she requested a policy supporting research programs that investigate this link through experimentation.

Dr Ghada Elabed claimed that food systems evolution in digitalization has benefits but also risks. The data-driven digital agriculture provides us new capacity to create, transform, and analyze this data to generate insights. However, there are many risks including data privacy issues and exacerbation of existing inequalities. She insisted that the digital revolution will have to be led by the private sector, but the public sector has to impose regulation to maximize the benefit and minimize the risks.

Dr Lee Ann Jackson called for better policies for food systems. While the current food systems are supporting the world's population, they have shortcomings including environmentally harmful outputs. She believes better policies can mitigate the negative effects and for better policy making, we have to overcome evidence gaps that currently exist. She says that the new emerging technologies can help policy makers choose better options.

Mr Matthew Tan introduced the circular economy in Singapore. Local production is consumed in a regenerative way and the byproducts are reformed into valuable materials. He offered two examples of food waste minimization by monitoring the entire value chain with blockchain.

Ms Pasinee Napombejra demonstrated the use of provincial crop calendar of Thailand. This calendar provides information on crop production and nutrition availability at the regional level. She says this calendar will serve as a digital tool that the governor and other stakeholders can benefit from.

Mr Dae-yeol Yoo introduced the current policy direction of Korea regarding overcoming the aging and climate change problems of Korean agriculture. The Korean government is focusing on providing young farmers with education and financial support. Smart agriculture infrastructure including smart farm demonstration complex is under construction. He expects Korea would develop an exemplary model of smart agriculture.

Appendix 1. Survey on digitalization in agriculture

Introduction

As the APEC Food Security Roadmap Towards 2030 was adopted for the long-term food security and nutrition of the APEC region, Korea conducted a survey on digitalization in agriculture to share policy experiences of member economies. It was intended to be a contribution to the fruitful execution of the Roadmap and tried to identify the most available policy schemes.

A total of 4 surveys were received out of 20 questionnaires distributed.

Overview of the Digital Agriculture Policies

Chile

R+D+i Strategy

The Chilean Agricultural Research Institute (INIA) is implementing an “R+D+i Strategy” for 2020~2030. This strategy aims to generate knowledge which adds value to decision-making by means of digital technology development and data processing. For this objective, INIA uses and develops digital agriculture to contribute to the development of competitive and sustainable agri-food systems at the domestic and international scale, with low environmental impact; optimizing management of environmental resources; and protecting crop health.

The expected outcomes of “R+D+i strategy” are,

- Assessment of abnormal conditions in crop development, in association with an early warning system.
- Penetration of smart mechanization as a foundation for reducing costs in agricultural production supplies and labour.
- Automated monitoring systems using artificial intelligence for efficient management of agricultural variables.

Major scheme: Establishment of an Emerging Technologies Ecosystems of Agro 4.0 base in Smart Field Development Model (budget: USD \$200,000)

INIA is responsible for the Digital Agriculture Program. It aims to establish efficient agricultural systems that integrate all the factors that affect productivity and environmental sustainability, which serve as models or pilots for their implementation in the private sector of all sizes, depending on their needs, and also as a training and information center for advisers, researchers, students interested in new applications of these technologies.

It will contribute to implementing a smart agricultural production system (Smart Field) on a commercial scale that integrates new and potential technologies called Agro 4.0, which validate productive efficiency, sustainability, and competitiveness. INIA will activate the usability of public-private scaling of Agro 4.0 technologies in the private production sector promoting the market-based local and international technology.

Main obstacles of digitalization in agriculture

| Categories | Responses |
|---|---|
| Farmhouse accommodation technology | False vision of the costs of new technologies or lack of critical analysis that accounts for the economic benefits of investing in this technology and the potential benefits that exist for end users (they do not always have a high cost) or lack of information and concrete examples at the domestic level |
| The certainty of the effectiveness of digital agriculture | They are not perceived as tools to increase competitiveness and producers do not have time available to learn and learn something new (Fear to the unknown, variables that do not depend on technology) |
| Lack of policy and persistence | Lack of support from financial institutions, producers are high-risk agricultural companies for banks |
| Collection and analysis of data | Lack of agro-economic studies, need to demonstrate that the use of technology is a profitable activity |
| Others | Non-technical problems, where producers and consultants are in a partial solution area, but acceptable without extra cost for the use of technology |

Policy recommendation

- The incorporation of new digital technologies in agriculture requires the reconversion of a part of the workforce, which has not been systematically addressed, and if this issue is not well addressed, it will be difficult to achieve advances swiftly.

Chinese Taipei

Smart Agriculture Program

From 2017 to 2022, a “Smart Agriculture Program” has been implemented by the Council of Agriculture. To encourage industries to develop smart agricultural technologies and raise the efficiency and capabilities of agriculture, the “Smart Agriculture Program” has introduced cross-disciplinary technologies such as information and communication technologies and focused on ten leading industries, promoting the use of “smart production” and “digital services.”

The Smart Agriculture Program introduces intelligent devices, sensing technology, Internet of Things (IoTs) and big data analysis to help digitize knowledge, automate production, optimize products and simplify operations. To promote the Smart Agriculture Program, we had prioritized ten industries for promotion: orchid, seedling, mushroom, rice, agricultural facility, exportation of major crops, offshore fishery, aquaculture, poultry and dairy. In order to strengthen the effective diffusion of technology and increase the participation of businesses, incentive programs were developed to encourage the transformation of agricultural industries; on the other hand, COA promotes “Smart Farmers Alliance” to build up new partnerships between contractors and agribusinesses and upgrading the competitiveness of the industry.

The impressive results of the “R+D+i strategy” were,

- i. Founding seven “smart farmers alliances” (for edamame, rice, poultry, lettuce, dairy, orchid and mushroom) for demonstration

- ii. Raising the output by \$35 million (USD) in the agricultural venues where smart agriculture was adopted
- iii. Encouraging industries to invest in innovative R&D through the “Industrial Technology Development Program,” with a total of over \$18 million (USD) invested by businesses participating in the Program
- iv. Encouraging agribusinesses to invest in the software and hardware of smart agriculture, with a total investment thus far over \$43 million (USD)
- v. Promoting 205 cooperative research projects between academia and industrial groups
- vi. Setting up a total of 147 demonstration sites while promoting active participation by industries

Major scheme: Development of diversified models of digital agricultural convenient service and value chain integration by integrating information technologies (budget: USD \$950,000/yr.)

The Department of Science and Technology of the Council of Agriculture is responsible for this scheme. Since Chinese Taipei implements the Smart Agriculture Program, it is certain that digital services are based on agri-data. For the reason that Chinese Taipei has built the Common Information Platform, it integrates official data and open data such as weather, pesticide, fertilizer, food safety, and market conditions to share with everyone in agriculture by OPEN API mechanism. The Common Information Platform is a digital service platform from production to marketing and linking the research results of various developers.

Chinese Taipei establishes a public basic system for digital services in smart agriculture (common information platform), integrate information and communication technologies, and promote new models of digital agriculture services to strengthen agricultural competitiveness. What has been completed so far includes the development of disease and pest prevention and diagnosis service tools integrated with Linebot and the plant protection network platform. It has built a digital avatar model through XGBoost, launched pilot digital services for greenhouse coaches/experts and greenhouse doctors, and launched three certification labels and one QR code verification digital services to create production and consumption matching contacts. The program also includes cooperation and supports on information technology and digital services with six leading industries including orchid, seedling, mushroom, rice, agricultural facility, and main crops for export.

In order to continuously implement smart agricultural technology in the industry, it is necessary to construct a smart agricultural industrial chain ecosystem or to industrialize smart agriculture. Through the development of the ecosystem and industrialization, it can promote the participation or cross-sectoral cooperation of more agricultural machinery, equipment, and hardware suppliers, and join hands in connecting research and development, manufacturing, production, and services to promote the digital transformation of agriculture, which can then be applied.

Main obstacles of digitalization in agriculture

| Categories | Responses |
|---------------------------------|--|
| Collection and analysis of data | Farming data isn't easy to handle, and information standardization for Smart Agriculture is still limited. |
| Others | Most of these technologies have only been tested on larger farms so far; the development of affordable smart agricultural equipment/systems is crucial to overcome and meet farmers' need. |

Policy recommendation

- Much more efforts in digital transformation of the current production and sales systems are needed.
- Cross-field capacity for smart agriculture needs to be nurtured systematically and continuously.
- Overcoming severe bottlenecks in food supply chain caused by the pandemic such as COVID-19 could be a challenge, but also an opportunity for Digital Agriculture.

Japan

Promotion of Smart Agriculture

In Japan, the number of farmers is decreasing, and the population is aging. In the field of agriculture, there are still a lot of labour-intensive tasks and works requiring skilled farmers. To address these issues, smart agriculture using advanced technology such as robots, AI and IoT is expected to save labour, secure manpower, and reduce the burden. Smart agriculture techniques are constantly advancing, and the technology demonstration is carried out through the project in Japan. Therefore, it is important to promote social implementation of the smart agriculture.

The Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan set a “Study Group for realizing smart agriculture” in 2013. The Group gathered momentums from national stakeholders. The Cabinet Office has launched the Cross-Ministerial Strategy Innovation Promotion Program to advance research and development intensively on smart agricultural techniques under the cooperation between the public and private sectors. Since 2019, the “Smart Agriculture Demonstration Project” has been implemented in Japan to verify the technical and managerial effects of smart agriculture technologies by having farmers actually use the technology. In 2020, "Comprehensive Package for Promoting Smart Agriculture" was formulated to accelerate social implementation of smart agriculture.

In the future, based on the policy package, under the cooperation of stakeholders, to realize the policy goal “Almost all the farmers will be able to practice data-driven agriculture by 2025”, the Ministry will take measures to promote smart agriculture intensively.

Major scheme: Comprehensive Package for Promoting Smart Agriculture

Through the Smart Agriculture Demonstration Project, various problems have been clarified, which include high initial cost, insufficient infrastructure, and inadequate learning opportunities for smart agricultural machines. In order to solve these issues and accelerate the implementation of smart agriculture in the field, the Comprehensive Package for Promoting Smart Agriculture was formulated by MAFF in October 2020.

The expected outcome of this scheme is that almost all the farmers will be able to practice data-driven agriculture by 2025.

There are five main pillars in the Comprehensive Package for Promoting Smart agriculture.

- i. Demonstration and analysis of smart agriculture:
 - Clarify the cost-effectiveness of smart technologies
 - Promote horizontal development of the technologies for various items and areas, including hilly/mountainous areas

- ii. Development of agricultural support services:
 - Reduce introduction costs
 - Enable everyone to use smart technologies
- iii. Development of a practical environment:
 - Improve the environment from both tangible and intangible aspects, such as farmland development and data utilization
- iv. Providing learning opportunities:
 - Develop human resources with smart agricultural technologies
 - Attract young people's interest
- v. Overseas expansion:
 - Strategically promote overseas expansion of smart agricultural technologies while paying attention to the protection of intellectual property

Main obstacles of digitalization in agriculture

- Through the Smart Agriculture Demonstration Project, some challenges have been identified, which includes high initial cost, insufficient infrastructure, and inadequate learning opportunities for smart agricultural machines.

Policy recommendation

- Smart agriculture is not a purpose but a means. It is important for farmers themselves to make a clear decision and act on their own. It is necessary to identify the issues in their agricultural management. Farmers must see whether smart agricultural technology is effective, or whether other means are appropriate to solve the issues. Governments should confirm the effects of the technology and support them soundly.

Russian Federation

Strategy for the development of the information society in the Russian Federation for 2017~2030 and National program "Digital Economy of the Russian Federation"

The strategy was approved by the Decree of the President of the Russian Federation of May 9, 2017, № 203 “On the Strategy for the Development of the Information Society in the Russian Federation for 2017 - 2030”. Also, the national program was approved by the order of the Government of the Russian Federation dated July 28, 2017, № 1632-r (Project timeline: 01.10.2018 - 31.12.2024).

It has three main objectives.

- Digital transformation of agriculture through implementation of digital technologies and platform solutions to ensure a technological breakthrough in the agro-industrial complex and achieve productivity growth in agricultural enterprises using digital solutions.
- Improving the effectiveness of state support measures in the field digitalization of the agro-industrial complex.
- Creation of a system for training specialists of agricultural enterprises to form their competencies in the field of the digital economy.

The main technological trend in agriculture is the use of precision farming. At the same time, the following main directions of development can be distinguished:

- Unmanned aerial vehicles (UAVs) and autopilot systems for agricultural machinery.
- Internet of things in agriculture.
- Artificial intelligence in the agro-industrial complex.
- Modern systems for monitoring agricultural land, a number of other technologies and solutions.

A state strategy has been developed in the field of building a digital economy in the Russian Federation. Through the implementation of government programs, sources of sustainable financing for digitalization of the agro-industrial complex have been identified.

There is a constant increase in the interest and participation of agricultural producers in the real use of digital technologies. According to the forecasts of the Ministry of Agriculture of the Russian Federation, by 2026, the market of information technologies in agriculture should grow at least five times compared to the indicators of 2019 (it was 360 billion rubles). According to the published data, as of 2021, the total IT budget for digitalization of 55 largest Russian agricultural holdings is 471 billion rubles.

Major scheme: Project «Digital Agriculture» (budget: 300 billion rubles)

This project has been implemented by the Ministry of Agriculture of the Russian Federation to ensure the development of the agro-industrial complex through the introduction of digital technologies and platform solutions in the agro-industrial complex.

The implementation period is 2019 - 2024. The project involves the creation and development of a national platform for digital public administration of agriculture “Digital Agriculture”, a module “Agro Solutions”, a sectoral electronic educational environment “Land of Knowledge”, as well as training specialists of agricultural enterprises to form their competencies in the digital economy. In the course of the development of the project, it is assumed that at least six projects of a complete innovative complex scientific and technical cycle of end-to-end digital systems will be introduced in the constituent entities of the Russian Federation: “Digital technologies in agro-industrial complex management”, “Digital land use”, “Smart field”, “Smart garden”, “Smart greenhouse”, and “Smart farm”.

An information system of digital services of the agro-industrial complex has been created to ensure that citizens and businesses can receive comprehensive government services in the field of agriculture, grouped by basic life situations in the field of state support. Trial operation was carried out with the participation of pilot regions and business representatives. Acceptance tests have been carried out. The system is ready for commissioning.

Also, the development of the system for the provision of state services in electronic form of the Ministry of Agriculture of the Russian Federation (software package “Electronic Services”) has been carried out. The Federal State Information System for Traceability of Grain and Grain Products has been created, which allows accounting for the volume of a batch of grain and the volume of a batch of grain processing products during their circulation. The development of the potential of the existing information systems of the Ministry of Agriculture of the Russian Federation has been carried out.

The government will develop the systems continuously for the provision of public services and services to the population and agricultural producers in the agricultural sector within the framework of the Digital Agriculture project.

Main obstacles of digitalization in agriculture

| Categories | Responses |
|---|---|
| Farmhouse accommodation technology | <ul style="list-style-type: none"> - Lack of sufficient financial resources for the implementation of information and communication technologies in the majority of agricultural producers, especially in small and medium-sized businesses. - Low level of provision with modern information technologies of industry enterprises due to the long absence of conditions for investment and development. - Insufficient development of basic digital infrastructure in rural areas. |
| The certainty of the effectiveness of digital agriculture | The absence in a number of regions of examples of effective implementation of digitalization projects in the field of agriculture, which could serve as a locomotive for the development of this area, insufficient information to agricultural producers by representatives of regional authorities about the available digital services and technologies. |
| Collection and analysis of data | The lack of a unified approach to standardizing processes, forms and formats for collecting, storing and transmitting complete and up-to-date information on agricultural land, natural factors, the availability of a resource base, the labour market, capital involved in agricultural production, and the marketing of products from taking into account the export-import component, which determines the current low degree of information exchange and limits the possibilities for planning and developing agriculture. |
| Others | A high level of shortage in the sectoral labour market of specialists capable of effectively working with innovative digital technologies. |

Policy recommendation

- In order to reduce the lag in labour productivity, productivity and other indicators from economies with traditionally developed agriculture in the Russian Federation, it is necessary to pay more attention to the development of state support measures in terms of stimulating the development of digital technologies in the agro-industrial complex.
- When developing concepts for digitalization projects, priority should be given to their implementation within the framework of platform solutions that allow combining a wide range of public services and services in the agro-industrial complex in a “single window”. It is also necessary to interact with the state information systems of the Ministry of Agriculture of the Russian Federation with systems and services of other federal executive bodies, which will reduce the time for making decisions on the requested service and implement its provision on the basis of a “single window”.