

UN CTCN Partnership and Liaison Office Pilot testing of Capacity Building Program: Concepts of Matchmaking and Peer-to-Peer Learning for Project ideation

Summary Report

Digital Technology Applications in Agriculture Sector

Background: In collaboration with Seoul National University Global R&DB Center (SNU GRC), the CTCN PALO delivered a 3-day capacity building program on 'Digital Technologies in the Agriculture Sector' from 14th to 16th December 2022 at Siheung SNU Campus, Republic of Korea. This report summarizes on the preliminary results of a co-creation process applied during the program to facilitate the engagement of participating countries in designing the next multi-country technical assistant (TA) project ideas.

Objectives: Guided by the CTCN's 3rd PoW, the aim of this program was twofold: 1) Knowledge transfer, introducing the latest digital technologies as potential ways to increase the overall efficiency, substitute the existing, and redesign the agriculture sector and 2) Encouraging collaboration, supporting participating countries to share their technology and policy needs and facilitating brainstorm of the next multi-country TA project ideas. The full program agenda can be found in Annex I.

Participated countries: A total of 30 delegates from 15 countries were invited. Of those, 26 delegates participated in this program. Except for the NDEs from Zimbabwe and Bangladesh, two delegates - one representing NDE and the Ministry of Agriculture - from Vietnam, Indonesia, Mongolia, Sri Lanka, Malaysia, Nepal, Thailand, Cuba, Ghana, Kenya, Cambodia, and Laos attended the program.

Approach: In order to achieve the program objectives, a co-creation process was applied through four sequential methods: segmentation, education-focused information distribution, national-level need identification, and participatory workshops. Table 1 illustrates all sub-activities and expected outputs of the process undertaken.

Table 1 Overall process of Co-creating Multi-country TA projects, facilitated by CTCN PALO

Process	Methods Applied	Program Activities	Outputs
1. Planning	Co-creating Multi-country TA projects	Segmentation	Pre-program survey
2. Sensitising		Information distribution	7 Keynote speech and 6 lecture presentations
3. Facilitating		Need identification	In-program survey and round table discussion
4. Engaging		Participatory workshops	Group discussion and idea board generation
5. Analysing		Evaluation	Post-program survey
			Identification of potential groups with similar digital technology needs for RD&D collaboration in agriculture sector
			Introduction to the concept of digitalization in agriculture technology innovation and the latest smart agriculture technologies applied
			Identification of each country's digital technology needs and potential TA activity ideas reflecting country priorities
			Identification of a potential multi-country TA project details (i.e. technology and policy strategies)
			Reaffirmation of all insights provided by participating countries

- 1) *Step 1: Planning:* This step focused on the application of the segmentation approach in order to identify potential multi-country TA subjects within the participating countries. The survey consisted of three sections: selecting a) the agricultural sector that is most urgent for digital innovation, b) a potential RD&D collaboration topic, and c) other system transformational areas of work that could be targeted with the agriculture sector. Regarding section B, smart agriculture RD&D research topics currently supported by the Korean government were listed as options to choose from. The list of Korean digital agriculture RD&D collaboration topics was provided considering the potential of supporting a direct networking opportunity with a local practitioner who have been developing or testing a specific digital technology for agriculture sector transformation. Of all local RD&D research implementers, two institutions are Network members who may connect with participating country representatives for an immediate preliminary RD&D collaboration (i.e. peer-to-peer learning), upon the country request.

The pre-survey received a total number of 24 valid responses. Within focus area of agriculture and livestock¹, 'Crop cultivation·production' (n=15) was found to be the most prioritized area for digitalization, followed by prioritization of 'Processing·storage·distribution' (n=6). Digital technologies improving the overall efficiency of the existing agriculture practice (n=31) and restructuring current agriculture market system to improve market acceptance of new/current products (n=21), were found to be the digital transformation areas² participants hope to adopt in future TA projects. W-E-F nexus (n=15) and Business industry (n=13) were the first and second areas of transformation that participants wanted to address along with the agriculture sector via RD&D collaboration for endogenous system innovation.

Without segmenting participants by their interests, the survey result generally informs the next TA project should focus on RD&D collaboration on digital technologies that could increase the overall efficiency of existing agriculture processes in crop cultivation and production area as part of the WEF nexus. However, when each participant's needs were analysed by their common interests, regardless of their official duties and geographical characteristic, seven potential multi-country TA project group demands were identifiable (details refer to Table 1).

Except for a few countries (i.e. Vietnam, Indonesia, Malaysia), incongruency in focus/interest areas between national ministry levels was observed, indicating communication among the country NDE and the sector-relevant officer is limited. Of all groups, the Group 4 (i.e. Sri Lanka, Thailand, Indonesia, and Mongolia) consisted

¹ Agriculture areas were a) Genetic resources and improvement, b) Crop cultivation·production, c) Livestock and livestock disease management, and d) Processing·storage·distribution. These areas were extracted from Taxonomy of climate adaptation technology (UNEP DTU & GTC, 2021)

² Digital transformation areas were a) Process (improving efficiency), b) Operation model (substituting existing techs), c) Domain (data-centred, digital ecosystem), and d) Culture (redesigning governance and society). The areas were the results of blending UNEP (2021) and Private/Academia's classification of digital transformation areas.

of the most NDEs, showed the greatest congruency in all areas of interests – agriculture, digital transformation areas, and system transformation for RD&D collaboration. Ghana, Zimbabwe, and Vietnam (countries part of Group 3) showed 100% matching in all areas of interest, indicating high potential for subject countries to plan next³ multi-country TA project for digitalization of agriculture sector.

Table 2 Summary of 'Pre-program survey' results

#	Participating countries grouped by matching interests in RD&D collaboration areas of agriculture, digital, and other transformation (Position: NDE, MA for Ministry of Agriculture)	Preferred agriculture areas	Preferred digital transformation areas	CTCN's 3 rd PoW system transformation areas for RD&D collaboration				
				Water-Energy-Food Nexus	Building and infrastructure	Sustainable Mobility	Energy systems	Business and industry
1	Bangladesh (NDE) Ghana (NDE) Vietnam (MA) Cuba (MA)*	Processing•storage•distribution	Improving the efficiency of existing processes via automation					
2	Ghana (MA) Zimbabwe (MA) Vietnam (NDE, MA) Lao PDR (NDE, MA)*	Crop cultivation•production						
3	Sri Lanka (MA) Thailand (MA) Kenya (NDE) Cambodia (MA) Nepal (NDE)							
4	Sri Lanka (NDE) Thailand (NDE) Indonesia (NDE, MA) Mongolia (NDE)		Substituting the technology with available digital technologies					
5	Cuba (NDE) Malaysia (NDE, MA)*							
6	Nepal (MA) Mongolia (MA)	Livestock and livestock disease management	Redesigning the culture related technologies to increase market acceptance					
7	Kenya (MA) Cambodia (NDE)	Genetic resources and improvement	Taking data centred approach (e.g. Building web services) to redesign the technologies' domain					

*Note. * = Country representative who did not specify most preferred system transformation areas, thereby assigned to groups only considering two (i.e. agriculture and digital transformation) out of three interest areas.*

- 2) Step 2: Sensitising: The second step of facilitating co-creation of the multi-country TA project aimed at transferring knowledge and information. Therefore, seven keynote speeches introducing the digital concepts related to improving agriculture efficiency, substituting and redesigning current practices were delivered in the first session of each day for two days. Six lecture presentations covering the smart farm

³ Rajiv's original comment: How can you conclude this. It could be that they have consulted each other better.
J1's reply: The 100% match among the three countries' interests was identified via independent pre-program survey response analysis. Was there any tri-party meeting with these countries (that I am not aware of), prior to them completing this pre-program survey? If so, this analysis is flawed. If not, it's a new insight that was identified via this pre-program survey analysis.

technologies development and deployment success cases and available finances were shared by the local agriculture-related climate-cooperation experts. This allowed participating country representatives to be sensitized to the program context of digital innovation in agriculture practices. Ideally, all keynote speeches delivered must have allowed the participants, who are typically not involved in the co-creation process, to reflect and prepare themselves for the next step of facilitation.

Annex II illustrates key knowledge delivered and discussed for each information distributed. Questions voluntarily asked by participants can be found in Table 3.

- 3) *Step 3: Facilitating:* Two individual activities namely in-program survey and round table of policy pitch presentation was held (see Figure 1). The in-program survey asked to provide details of a previous agriculture-related climate technology transfer project that the participants liked the most. Thematic analysis of the individual survey responses (n=26) revealed potential activities of the next multi-country TA project in digital agriculture sector as follow: 1) Community-based social communication strategy development to examine market potential and to increase market acceptance of transferred agri-techs, 2) Developing a science-based⁴ decision-making tool (i.e. ROI / LCA / LCC) to assess sustainability of the TA project, and 3) Repeating pilot tested⁵ technologies into other regions/cities to increase the validity of the technology transferred.

⁴ Rajiv's comments: Is this feasibility or cost benefit analysis

J1's reply: The participants did not mention a specific research tool in their responses, however, they mentioned that they liked the agri-related projects with profit-analysis component. So more towards cost-benefit. For clarity, added couple of examples of potential decision-making tools.

⁵ Rajiv's comments: Is this replication or scale up

J1's reply: When 'How would you do it differently if you get another change to redo the project' was asked, majority of the participants replied, 'repeat the same technology testing in a different region of the country to increase validity of technology transferred'. It implies that they view 'scale up' as in increasing quality (=effectiveness=localisation) of the tech transferred, not quantity (=number of cities/region) of TA.




Individual activity

Your name: _____ Your country: _____

Q1) Please tell us the most incredible program/project details!

A. Year of implementation: _____

B. Title of the project: _____

C. Purpose/aim of the project: _____

D. Type of technology applied: _____

E. Name of the project site (where): _____

F. Total budget spent: _____

G. Impact measure(s) applied: _____

H. Outcome(s) achieved: _____

I. What was so fascinating about this project? _____

Q2) How would you do it differently if you got another chance to redo the project?

Thank you for sharing!



Figure 1 In-program survey questionnaire and round table policy presentation

Considering the promotion of North-South, South-South and triangular collaboration on RD&D, two additional activities were identified based on the participants' elaboration on their country's agriculture-related policies: 5) Mapping of current agriculture sector governance to identify the missing infrastructure (i.e. national/local level expert (individual)/research institute/university), and 6) Developing workplan for each national/local research institutions and farmers/communities reflecting existing agriculture related national policies. The summary of each country's 5-minute round presentation on their agriculture-policies and questions voluntarily asked to presenters can be found in Table 3.

Table 3 Summary of participants responses to sensitising and facilitation-focused activities

Country	Notes taken from round table policy presentation	Questions asked to presenters
Bangladesh	(Background) 84% of population rely on agriculture sector, problem with food security, socio economic, production of crops, crop diversification (National plans) 2041 national plan focuses on improvement of 'action' whereas 2015-2030 plan had inconsistent projects, focused on building institutions for commercialization of crops (Challenges related to technology transfer) Lack of basic database and high price fertilizer (Challenges related to agriculture sector) Heavy rainfall and cyclones	

Cambodia	- (Background) Agriculture sector covered 50% of economy, now 24% decrease in the agri economy. Export of raw material (rice, 80% of cultivated area) - (National plans) Agriculture plan focusing on climate resilience on land irrigation, by 2030, the country aims to increase productivity, attempt to commercialize high quality products - (Challenges related to agriculture sector) Frequent floodings negatively affecting regional soil area control stability - (Challenges related to technology transfer) Farmer engagement is limited due to lack of capacity, funding, resources	
Cuba	- (Background/National plan) Application of policy mix: Supreme law related to food production, R&D centers (30% food production focused universities), innovation centers are already in-place. Territorial local policy mix under implementation, based on the local needs. Bio tech is a state of art level tech in Cuba (Robot technologies for sustainability - Bio & Genetical composition for corn, bean). - (Challenges related to agriculture sector) U.S.-Cuban relations affecting Cuba's agroecology revolution - (Challenges related to technology transfer) Lack of social communication strategy adopting social science techniques to allow committee led approach (key stakeholder involvement) like National commission.	How to form a governance foster involvement/engagement of key stakeholders (e.g. living lab)
Ghana	- (Background/National plan) Heavily agriculture dependent economy. Established food and agriculture sector framework to foster modernization of agriculture to improve economy, poverty, employment, nutrient - (Challenges related to agriculture sector) Increasing income of farmers (shared world bank's case on water management project for farmers which successfully increased the overall income of farmers) - (Challenges related to technology transfer) Lack of institutional capacity, and production system at local level, no governance, impact measures to assess modernized agriculture practice	How to prevent job security challenges that automation may cause
Indonesia	- (Background/National plan) Steady increase in agriculture sector practices, agriculture is #4 sector in economy. National plans aim to decrease 0.3% of agriculture-related carbon footprint. - (Challenges related to agriculture sector) Food production is key rather than agriculture mitigation, thus slightly conflicting national plan to economy-priority. - (Challenges related to technology transfer) National 4 main agri-techs (i.e., water management, biogas, cattle methane reducing) are announced but data monitoring system is not operating very well.	
Kenya	- (Background) The agricultural sector contributes about 25% of Kenya's GDP and about 27% indirectly through linkages to agro-based industries and the service sector. Crops contribute up to 70% agricultural exports - (National plan) Supreme Law: Kenya Constitution 2010 and the vision 2030 - (Challenges related to technology transfer in agriculture sector) Multiple national policies (Research Act, Growth Strategy 2019-2029, 2021 Agriculture policy, etc) are under implementation, indicating necessity to examine current policies to design a TA project that reflects these policies	How to engage younger generation and compensate trade and commerce fee for the farmers to purchase the technology (i.e. weather station, own devices, software)
Lao PDR	- (Background/National plan) 2011-2020: Improving living hood and activity, Modernize production of commodity, sustainable product stabilizers. 2025-2030: National food security, agriculture production, private investment - (Challenges related to agriculture sector) Cooperating with China (90% of product goes to China), private businesses participation and traditional farmers (i.e. automatization is hard due to lack of interest of farmers paying the fee)	
Malaysia	- (Challenges related to agriculture sector) Food security and industry participation improvement	How to conduct data composition (EBS - Enterprise business system adoption to increase data standardization / representative

	(Challenges related to technology transfer) Already adopted IOT, bigdata, however, no synchronization of technologies adopted. Missing data collection and improvement solutions.	farm selection - several years of tracking, weather/cropped)
Mongolia	(Background/National plan) 20% of GDP of Mongolia (14% of currency revenue). Agri-timeline shorter than (5months of the year, May-October) other countries. Short, mid, long-term policies 2050 document: Quality of life (already multi-sector) (Challenges related to technology transfer) Climate change information system (ICT institution supported, mainly with meteorology scientist) and ICT on-site already. However, mechanization and biotechnology related private sector is smaller than public sector. Capacity of farmers and institutions to fair share of benefits along the value-chain is low. (Challenges related to agriculture sector) Management of genetic crop and plant varieties. Should focus on modernizing the value-chain, labor productivity, increasing competitiveness and knowledge for sustainable production (stational services and local training).	
Nepal	(Background/National plan) 70% on agriculture, 25% contributing to GDP. High focus on crop & livestock. National adaptation plan 2025 on food security program. Agriculture plan 2015-2035 under implementation. Focus on Agro-diversity, family farming, Agro-forestry policy. 353 local governments. - Commercialization and mechanization to gain competitiveness in the market. Only small market for the farmers (not sufficient profit for the farmers) (Challenges related to technology transfer) Lack of digital technologies o to regulate market system	The presented technologies seem too advanced (Presenter response: Some of these technologies can be utilized by a smartphone).
Sri Lanka	(Background/National plan) Under implementation of new agriculture policy. Known as a global bio-diversity hotspot allowing growth of different crops (Challenges related to technology transfer in agriculture sector) Lack of recipes to make new crops familiar with young generation. Balancing out ecosystem. Keeping bio-diversity to ensure food security, sustaining our natural resource base (without giving more pressure on natural resources/prevent outbreaks)	How to involve local voices? Any social marketing (behaviour change) strategies in these technologies to allow technological and social innovations with the community?
Thailand	(Background/National plan) Action plan: Data centered operation, agency coordination, management, governance. 2025-27: CSA (by adopting FAO's perspective). Already have innovation center, logistic system, water management, large scale farming management, crop insurance, competitiveness, R&D, National big data center (Challenges related to technology transfer in agriculture sector) Natural disaster, early warning system must be considered as part of Agriculture (+ Potential to link with W-E-F nexus). Marketing-led production, monitors demand for equilibrium. Limited links to mitigation. Limited data and information, manpower (researcher involvement) and capacity building efforts.	
Vietnam	(Background/National plan) 60% of products are exported to China. Private businesses focus on production (Challenges related to agriculture sector) Policy change in China affects Vietnam's agriculture practice. Lack of business model on consumption leading to more supply than demand. Food poison and control of the product quality (Challenges related to technology transfer) Synchronizing data collection to predict coastline related storms and floodings (as part of early warning prevention system establishment)	
Zimbabwe	(Background/National plan) 70% population in agriculture sector, small scale farmers, 30% in urban areas. NDC - 40% per capita, mitigation for forestry section. Agriculture to support mitigation and is an economy booster (Agri-e-commerce, smart farming). Ongoing surface level implementation. National agri culture framework under implementation to enable SMS platforms to support small farmers with lack of electricity, affordability, digital literacy (but only small percentage of people using the service/app even its supported)	How to support small holder farmers vs commercial farmers

	- (Challenges related to technology transfer in agriculture sector) Shared the case of World Bank invested 50-75million US dollars in ICT to allow private mobile service providers in the country. GIS remote sensing available. Lack of crop and livestock extension materials, agriculture marketing, institutional participation.	
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- 4) *Step 4. Engaging⁶*: Over two days of the program, two group discussions focusing on technology identification and policy idea generation were held. All group discussions were facilitated by CTCN office members. Prior to each group discussion, the aim of this activity, pre-program survey results, and various policy tools (i.e. Education, Nudge, Law, Social Marketing, Communications) other than technology mechanism tools (i.e. Technical assistance, Capacity building, Networking) were briefly introduced to the participants. Following materials were prepared to support the co-creation of multi-country TA project ideas reflecting each participating country's perspective on digital technology RD&D collaboration for the agriculture sector: a) Group activity sheet, consisting of the list of all technologies that the grouped participants mentioned in the pre-program survey and b) Idea board, guiding creation of policy details (see Figure 2).

⁶ Rajiv's comment: CTCN follows a country driven approach. The CB is for awareness, knowledge and exchange of info. We don't co-design projects on TAs.

Jl's reply: As you can read it from the report, CTCN supported the co-creation of multi-country TA project idea generation among participating representatives by sharing summary of pre-survey responses that each participants completed and information on latest digital agri-techs. Meaning I was there as a facilitator of country discussion and listener of their needs, not as an idea co-generator representing CTCN's perspective. If we were "co-creating" or "co-designing" the project with them, then I would have involved CTCN's regional managers to each group discussion, however, that did not happen. Because as you said, we follow country-demand driven approach. I've updated the report to avoid misunderstanding of us (CTCN office members) shaping each country's needs.

For your information, co-design is a tool that often used in bottom-up driven policy development (similar to a citizen participatory policy dialogue). Co-design process allow key stakeholders to voice up their needs in a product/service development thus, proven to be effective in increasing the policy acceptance. In co-design process (which takes co-creation approach), a researchers or organizer (in our context, us) presents appropriate information and materials to rightfully facilitate solution-focused discussion among participating stakeholders.

Here, one of the appropriate information was me presenting the summary results of pre-survey completed by each participants. It was to ease their understanding to common needs/wants among themselves. Second appropriate information came from presenters illustrating potential digital techs/frameworks that can be applied to each country context. Third, different type of policy tools that NDEs may consider adopting in designing their agriculture-tech policy was briefly presented. In social science field, the most commonly applied policy tools to foster social change are education (knowledge building/information distribution), nudge (foster unconscious/involuntary behaviour change), law (forced behaviour change), social marketing (voluntary behavior change), and communications (awareness raising/movement creation) and these tools are applied depending on the characteristics of a target audience. Idea board with keywords (i.e. for whom, engage who, where would the TA be applied) was utilized as one of the materials supporting the group discussion.




G1: Bangladesh, Ghana, Vietnam, Cuba

Aim: Digitalization of Agriculture sector with Building and infrastructure and Sustainable Mobility sectors

Target: Improving the efficiency of existing processes on Processing•storage•distribution areas

Add technologies you'd prefer transferring to the list:

- Technology related to Growing, Harvesting and Processing
- High technique Agriculture
- Any technology that can be easily adapted to improve production and storage

Your group's final decision (pick one or two):

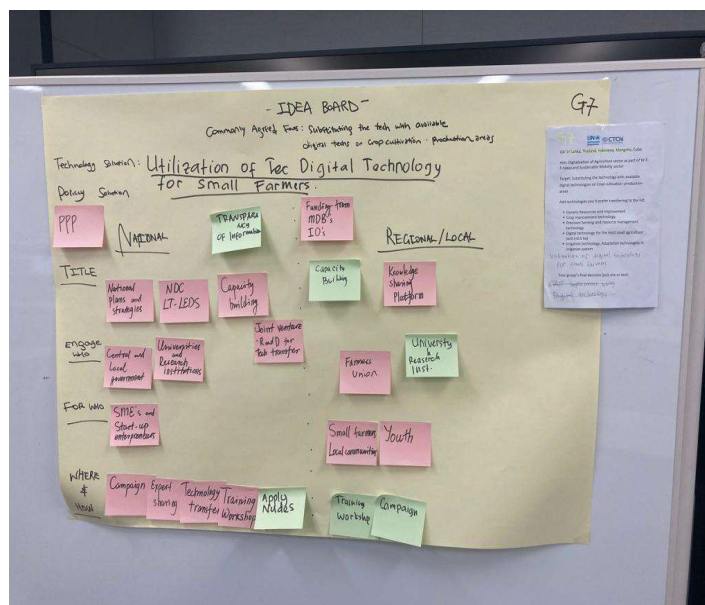


Figure 2 Group activity sheet and example of idea board

The average duration of each group discussion was 30 minutes (see Figure 3). During the discussion, participants were asked to identify each group's most preferred digital technology for agriculture innovation and brainstorm potential national or local level policies to accelerate the transfer of the digital technology chosen (refer to Table 4). When designing the policies, participants were asked to identify type of policy, partners to engage in executing the policy, target area for the pilot test, recipients, and communication strategy. As a result, a total of 7 potential multi-country TA project ideas was created by the grouped participants (see Annex III for all idea boards).



Figure 3 Participatory workshop

The most frequently mentioned type of policy was small-scale pilot testing of the digital technology chosen. Willingness to engage Government (line Ministries) and National/local research institutions as partners to enable policy landing was observed. A lack of a user-centered approach in policy development was found, as farmers most frequently mentioned as the recipients of the policy created were less considered partners to engage in the policy implementation process. Such tendency led to limited idea generation on placement and promotion strategies of the policy co-created. All co-created ideas were compared against smart agriculture RD&D research topics under implementation in Korea to identify potential RD&D collaboration opportunities (far right column of Table 4).

Table 4 Summary of co-created potential multi-country TA projects

#	Grouped participants by representing countries (Positions: NDE, MA for Ministry of Agriculture)	Preferred agriculture areas	Preferred digital transformation areas	Most commonly agreed digital technology and its purpose	Policy solutions to increase overall impact of chosen technology transfer					Willingness to submit a request form related to the co-created multi-country TA project ideas (Timing of submission)	Similar smart agriculture RD&D research topics supported by the Korean government and implementing institute
					Title of policy	Type of policy	Partners to engage	Recipients of the policy	Location, timeline, and message framing		
1	Bangladesh (NDE) Ghana (NDE) Vietnam (MA) Cuba (MA)*	Processing• storage•distribution	Improving the efficiency of existing processes via automation	Drone technology, to improve productivity and storage of agriculture products / services	The use of drones for production and automation of storage facilities to improve quality of services	Small scale pilot testing	National institutions, Universities, Research institutions, Tech company, NGO	Farmers, local communities, private partners	Village/Municipality (10 local authorities for pilot project)	➤ Bangladesh (Not sure) ➤ Ghana (Within 3-months) ➤ Vietnam (Within a week) ➤ Cuba (Within a year)	• Development of Unmanned Automation Next Generation High-Density Crop Cultivation Container System (N.THING) • Development of Smart Greenhouse Management and Production Management Technology (Jinong) • Development of High Productivity Greenhouse Environment Monitoring and Regulation Technology (Chungnam Agricultural Research & Extension Services - Fruit and Vegetable Research Institute) • Development of 2nd Generation Smart Greenhouse Productivity Demonstration/Adva

#	Grouped participants by representing countries (Positions: NDE, MA for Ministry of Agriculture)	Preferred agriculture areas	Preferred digital transformation areas	Most commonly agreed digital technology and its purpose	Policy solutions to increase overall impact of chosen technology transfer					Willingness to submit a request form related to the co-created multi-country TA project ideas (Timing of submission)	Similar smart agriculture RD&D research topics supported by the Korean government and implementing institute
					Title of policy	Type of policy	Partners to engage	Recipients of the policy	Location, timeline, and message framing		
											anced and Intelligent Environmental Control Model (Daoncnt)

2	Ghana (MA) Zimbabwe (MA) Vietnam (NDE, MA) Lao PDR (NDE, MA)*	Crop cultivation• production		Mechanization of Climate Smart Agriculture Practices, to increase knowledge and skills of farmers, and allow data sharing between countries	Establish institutional technical support mechanism	Participatory training programs	Private and public sector, NGOs, Local and sub-national Government, Farmers, Research institutes including Universities	Farmers, local governments, SMEs	For Lao PDR (North, central, south); Vietnam (North, central, south), Zimbabwe (South), 2 years	➤ Ghana (Within 6-months) ➤ Zimbabwe (N/A**) ➤ Vietnam (Within a week) ➤ Lao PDR (Within a year)	• Development of a fully autonomous complex environment control platform for smart greenhouses using artificial intelligence (KIST***) • Development and demonstration of unmanned autonomous smart model farm developed and applied MCU board exclusively for K-FARM (KIST***) • Smart greenhouse energy and carbon dioxide management monitoring and optimal design simulator development (Kangwon University) • Development of Intelligent Agricultural Work Robot for Smart Greenhouse (KITECH) • Development of Recycled Hydroponic Cultivation System for Smart Greenhouses (National Institute of Horticultural & Herbal Science) • Development of Smart Greenhouse Unmanned Control-
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											Based Technology for Hydroponics (National Institute of Agricultural Sciences)
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#	Grouped participants by representing countries (Positions: NDE, MA for Ministry of Agriculture)	Preferred agriculture areas	Preferred digital transformation areas	Most commonly agreed digital technology and its purpose	Policy solutions to increase overall impact of chosen technology transfer					Willingness to submit a request form related to the co-created multi-country TA project ideas (Timing of submission)	Similar smart agriculture RD&D research topics supported by the Korean government and implementing institute
					Title of policy	Type of policy	Partners to engage	Recipients of the policy	Location, timeline, and message framing		
3	Sri Lanka (MA) Thailand (MA) Kenya (NDE) Cambodia (MA) Nepal (NDE)			Crop-post-harvest digital technologies, to reduce losses	Develop technologies to reduce post-harvest losses (Storage facility and transportation focused)	Small scale pilot testing utilising MOUs between stakeholders and policy dialogue	Research institutes, Metrology for data information, private sector	Farmers, local communities	Not identified	➤ Sri Lanka (Within a month) ➤ Thailand (Within a year) ➤ Kenya (Within a year) ➤ Cambodia (Within 3-months) ➤ Nepal (N/A**)	• Development of Smart Greenhouse Cooling and Heating Package in Response to Abnormal Climate (Mokpo University) • Next-generation renewable smart greenhouse cooling technology based on storing and using natural cold air between seasons (KIER***)
4	Sri Lanka (NDE) Thailand (NDE) Indonesia (NDE, MA) Mongolia (NDE)		Substituting the technology with available digital technologies	Digital technologies for small farmers	Development of knowledge sharing platform	Information sharing, Joint venture R&D for tech transfer, capacity building	Central and local government, Universities, and research institutes	SMEs and Start-up entrepreneurs, Farmers Union, Youth	Comms campaign including nudge	➤ Sri Lanka (Within a month) ➤ Thailand (Not sure) ➤ Indonesia (Within a year) ➤ Mongolia (N/A**)	• Development of precision growth and biological characteristics measurement and diagnosis technology of fruit and vegetables in image infrastructure (Jeonnam Agricultural Research & Extension Services) • Development and demonstration of low-power and light-weight multi-sensor system for smart greenhouse (National

#	Grouped participants by representing countries (Positions: NDE, MA for Ministry of Agriculture)	Preferred agriculture areas	Preferred digital transformation areas	Most commonly agreed digital technology and its purpose	Policy solutions to increase overall impact of chosen technology transfer					Willingness to submit a request form related to the co-created multi-country TA project ideas (Timing of submission)	Similar smart agriculture RD&D research topics supported by the Korean government and implementing institute
					Title of policy	Type of policy	Partners to engage	Recipients of the policy	Location, timeline, and message framing		
											Institute of Agricultural Sciences)
5	Cuba (NDE) Malaysia (NDE, MA)*			Big Data technology, to improve precision farming, resource management, and genetic resource	Development of National Agriculture Big Data through synchronization/streaming of all related information	National level system development and R&D collaboration, matching grants (Joint venture), incubators	GCF, CTCN, local banks, Crowd sourcing mechanism	Government, agencies (i.e. regional farmers cooperation), SMEs	Not identified	➤ Cuba (Within 3-months) ➤ Malaysia (Within 3-months)	• Development of big data platform for management of autonomous smart greenhouse production environment based on artificial intelligence (Sunchon National University) • Development and demonstration of smart seedling standardization technology based on big data (Jeonnam Agricultural Research & Extension Services)
6	Nepal (MA) Mongolia (MA)	Livestock and livestock disease management	Redesigning the culture related technologies to increase market acceptance	Digital technologies supporting small farmers for sale/profit	Capacity building for small farmers	Capacity building including group discussion and training	Government (line ministries), agriculture sector, finance experts, NGOs	Small farmers working on crop and livestock	Agricultural areas, local market areas	➤ Nepal (Not sure) ➤ Mongolia (Within 6-months)	• Development of Smart Farm (Livestock-focused) Farming Consulting Expert System (Hohyun F&C) • Development of Northern Smart Farm Package Model for Export (International

#	Grouped participants by representing countries (Positions: NDE, MA for Ministry of Agriculture)	Preferred agriculture areas	Preferred digital transformation areas	Most commonly agreed digital technology and its purpose	Policy solutions to increase overall impact of chosen technology transfer					Willingness to submit a request form related to the co-created multi-country TA project ideas (Timing of submission)	Similar smart agriculture RD&D research topics supported by the Korean government and implementing institute
					Title of policy	Type of policy	Partners to engage	Recipients of the policy	Location, timeline, and message framing		
											Horticultural Research Institute) Development of High Temperature and Humidity Smart Greenhouse Package Model for Export (Sherpa Space)
7	Kenya (MA) Cambodia (NDE)	Genetic resources and improvement	Taking data centred approach (e.g. Building web services) to redesign the technologies' domain	Digital technologies improving the traditional agriculture practices	Technologies for improving the traditional agriculture sector through digitalisation	Small scale pilot testing with joint farmer research component	Government (National and sub-national levels), private sector, farmers, technical advisory	Farmers, private sector, research institutions, training institutions	Not identified	- Kenya (N/A**) - Cambodia (Not sure)	Development of Selective Light Transmission Solar Cell Technology for Smart Greenhouse (KIST***)

*Note. * = Countries did not specify most preferred system transformation areas, thereby assigned to groups only considering two (i.e. agriculture and digital transformation) out of three interest areas.*

*** = N/A for those who did not complete the post-program survey to indicate their willingness to submit the RFs.*

**** = CTC Network member.*

- 4) *Step 5. Analysis:* This step involved analyses of each activity and the program evaluation to address room for improvement in the future capacity-building program design and implementation. Thus, participants were asked to rank the order of each session by its level of interest, engagement, and information sharing. One open question was collected to allow participants to provide narrative evaluation of the least interesting/engaging/informative session. Most importantly, triangulation of all data collected was performed to identify detailed action plans for future practice. The participants' responses to questions on their willingness to submit a request form and predicted timing of its submission were utilised in the triangulation analysis.

A total of 20 responses were collected for the program evaluation survey. The participants found the presentations on digital solutions replacing current agriculture techs most interesting. Case studies showcasing digital solutions that could improve efficiency of current agriculture practice was perceived most informative. Round table discussion on each country's agriculture policies found to be most engaging session of all. They mentioned exposure to and interactive discussion on new digital technologies with speakers made these sessions intriguing. This indicates potential for a peer-to-peer learning formatted capacity building program to be successful in transferring technology-related knowledge.

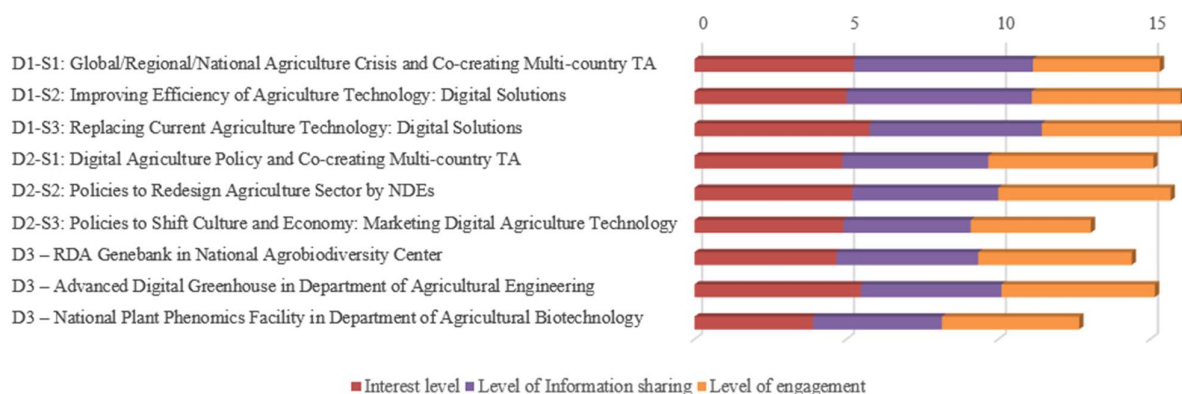


Figure 4 Average ranking score of each session

On contrarily, the field visit to the National Plant Phenomics Facility found to be least interesting. In relation to this, the participants questioned perceived applicability of presented technologies to their country. This indicates each country's level of readiness to adopt certain technologies must be reflected in design of future capacity building program contents. Also, presentation delivered by GCF colleagues found to be the least informative and engaging. Different ways to present available finance schemes that could enable design of sustainable and economy-driven TA project must be considered.

Of 20 respondents, 16 mentioned that they are willing to submit a request form related to co-created multi-country TA project idea (see Figure 5). Both the NDE and Ministry of Agriculture representatives of Vietnam mentioned they are willing to submit the request form within a week. Sri Lanka representatives claimed they hope to submit the request within a month. Within 3 months, the NDE representatives of Cuba and Ghana and Ministry of Agriculture representatives of Cambodia and Malaysia will submit the request form. Officers from Ministry of Agriculture Ghana



Figure 5 Willingness to submit a request form by participated countries

and Mongolia stated 6 months of preparation time is needed to submit the request form. The NDEs of Indonesia, Lao PDR, Kenya and the officers from Ministry of Agriculture representatives Indonesia, Cuba, Thailand are willing to submit the request form within a year.

On the other hand, the NDEs of Thailand and Bangladesh were reluctant to submit the request as s/he perceive the agree theme project may not be the best interest of their countries. Cambodia NDE stated more capacity building program on TA process should be provided for their country to submit the request form. Lastly, officer from Ministry of Agriculture Nepal mentioned most of the presented technologies are high techs, reaffirming the importance of taking each country's readiness in next capacity building program design. The actual submission of the RFs must be monitored. Second column from right of Table 4 summarizes each participating representatives' willingness to submit the RFs by their grouped TA ideas. The overall satisfaction rate of the program received 4.4 out of 5.

Conclusion

The five-step co-creation process facilitated by CTCN PAL Office members during the capacity building program on digital innovation in agriculture sector concludes actionable items to support multi-country TA project development are as follow.

- Considering the congruency and consistency in the responses of participated country representatives across all collected insights, Top 4 multi-country TA project ideas that CTCN climate technology managers may follow-up with participated countries for further enhancement are:
 - a. The use of drones for production and automation of storage facilities to improve quality of services,
 - b. Mechanization of Climate Smart Agriculture Practices, to increase knowledge and skills of farmers, and allow data sharing between countries,
 - c. Development of knowledge sharing platform of digital technologies for small farmers,
 - d. Development of National Agriculture Big Data through synchronization/streaming of all related information.
- 5 potential TA activities that are favorable by participating countries are:
 - a. Community-based social communication strategy development to examine market potential and to increase market acceptance of transferred agri-techs,
 - b. Developing a science-based decision-making tool (i.e. ROI / LCA / LCC) to assess sustainability of the TA project,
 - c. Repeating pilot tested technologies into other regions/cities to increase the validity of the technology transferred,
 - d. Mapping of current agriculture sector governance to identify the missing infrastructure (i.e. national/local level expert (individual)/research institute/university), and
 - e. Developing workplan for each national/local research institutions and farmers/communities reflecting existing agriculture related national policies.
- Upon country's request, CTCN may offer peer-to-peer mentoring session allowing direct learning from local experts who has experience in implementing TA project similar to generated ideas to ensure the foundations for preliminary R&D collaboration support.

The participants' voluntary and candid responses to submitting request form related to co-created multi-country TA project idea revealed six important lessons for future capacity building program design as:

- a. Number of countries participating for co-creating TA project idea should not exceed more than three (i.e. larger group dynamic may fail to reflect few participating countries' voices) and extend the duration of group sessions,
- b. Sector-relevant officers must be invited together with NDEs to all future co-creating TA project idea activities,
- c. Sub-activity on prioritizing interest areas of change at a national level, prior to multi-country discussion, should be facilitated,
- d. Conduct analysis of Network member's capacity for RD&D collaboration to allow engagement of network member in sharing case studies of developing countries,
- e. Reflect each country's level of readiness to adopt certain technologies in design of future capacity building program contents, and
- f. Offer available finance schemes that could enable design of sustainable and economy-driven TA project in different way (i.e. online learning).

Annex I – Final program agenda

CAPACITY BUILDING PROGRAM Digital Technology Applications in the Agriculture Sector December 14 ~ 16, 2022 Siheung, Republic of Korea 			
VENUE #406, Education Cooperation Building, Seoul National University Siheung Smart Campus			
DAY	TIME	DUR.	CONTENT
DAY 01 DEC 14 WED	Opening Ceremony		
	10:00~10:05	5	Introduction to Program
	10:05~10:10	5	Opening Remarks
	10:10~10:15	5	Welcoming Remarks
	10:15~10:20	5	Congratulatory Remarks
	10:20~10:25	5	Congratulatory Remarks
	10:25~10:30	5	Congratulatory Remarks
	10:30~10:35	5	Notice
	10:35~10:45	10	Group Photoshoot
	[SESSION1] Global/Regional/National Agriculture Crisis and Problem Identification		
	10:45~11:10	25	Keynote Speech Improving Efficiency and Sustainability through Green Agro-Innovation (GAI)
	11:10~11:45	35	Problem Identification
	11:45~13:00	75	Lunch Break
	[SESSION2] Improving Efficiency of Agriculture Technology: Digital Solutions		
	13:00~13:25	25	Keynote Speech Driving Efficiency and Productivity in Digital Agriculture: Digital Solutions Case for Agricultural Innovation
	13:25~13:50	25	Keynote Speech Application of Data Sciences in the Digitalization of Agriculture
	13:50~14:05	15	Presentation Weather Intelligence for Digital Agriculture Case of Laos
	14:05~14:20	15	Presentation Case of RD&D Collaboration to Improve Efficiency of Agri-test
	14:20~14:40	20	Q&A Session
	14:40~15:00	20	Break Time
	[SESSION3] Replacing Current Agriculture Technology: Digital Solutions		
	15:00~15:25	25	Keynote Speech Concept of 'Substitution' in Digital Agriculture Technology: Green Infrastructure to Supplement and Substitute for Vulnerable Agriculture Resources
	15:25~15:50	25	Keynote Speech Microsensing and Data Processing Technology for Agriculture Industry and Future Generations
	15:50~16:05	15	Presentation Case of Teloform for Replacing Current Agriculture Technology
	16:05~16:20	15	Presentation Case of RD&D Collaboration to Replace Current Agri-test
	16:20~16:40	20	Q&A Session
DAY 02 DEC 15 THUR	[SESSION1] Digital Agriculture Policy and Problem Identification		
	10:00~10:25	25	Keynote Speech Innovative Digital Agriculture Technologies and Challenges
	10:25~11:00	35	Round Table Discussion
	11:00~11:10	10	Break Time
	[SESSION2] Policies to Redesign Agriculture Sector by NDEs		
	11:10~11:35	25	Keynote Speech Building New Digital Agriculture Business Ecosystem and Policy Framework
	11:35~12:05	30	Policy Need Identification
	12:05~13:20	75	Lunch Break
	[SESSION3] Policies to Shift Culture and Economy: Marketing Digital Agriculture Technology		
	13:20~13:35	15	Presentation Climate Intelligence and Agricultural Resilience
	13:35~13:50	15	Presentation GCF's RFP Approach to Support Business Incubation and Acceleration and Establishment of Ecosystems, Focusing on Agriculture
	13:50~14:10	20	Q&A Session
	14:10~14:25	15	Reflection and Closing
	14:25~15:00	35	Music Performance
	15:00~		Bilateral Meeting
DAY 03 DEC 16 FRI	Field Trip		
	06:00~09:00	180	Relocation
	09:00~12:00	180	[Site Visit] National Institute of Agricultural Sciences of Rural Development Administration Smart Farm Valley in Jeonju
	12:00~12:30	30	Relocation
	12:30~13:30	60	Lunch Break
	13:30~16:00	150	[Site Visit] Jeonju Hanok Village
	16:00~19:00	180	Relocation

Appendix II – Summary of key knowledge delivered and discussed

- Keynote Speech by Prof. Junseok Hwang, Director of Seoul National University Global R&DB Center (GRC) on 'Improving Efficiency and Sustainability through Green Agro-Innovation (GAI)'
 - Global risks and the significance of climate risks affecting agricultural ecosystem and food security
 - New integrative digital technologies that enable agro-innovation (GAI) and their cases
- Keynote Speech by Prof. Chang-Gil Kim, Visiting Scholar, Seoul National University Asia Center on 'Driving Efficiency and Productivity in Digital Agriculture: Digital Solutions Case for Agricultural Innovation'
 - Historical phases of agricultural innovation through the whole human history spectrum
 - New technologies enabling digital agricultural revolution
 - Building the Agricultural Data Integration Platform
- Keynote Speech by Prof. Prof. Do-il Yoo, Professor of Department of Agricultural Economics and Rural Development, Seoul National University on 'Application of Data Sciences in the Digitalization of Agriculture'
 - Concept of digital (smart) agriculture
 - Policies for Smart Agriculture
 - Technologies for Digital Agriculture
 - Application of Data Sciences
- Presentation by Mr. Jongsun Park, General Manager of the Solution Business Team, EPINET on 'Weather Intelligence for Digital Agriculture Case of Laos'
 - Implementation case of Laos Climate Services for Agriculture (LaCSA)
 - System components of LaCSA
- Presentation by Dr. Keunpyo LEE, Senior Scientist, Executive Secretariat of KAFACI on 'Case of RD&D Collaboration to Improve Efficiency of Agri-techn'
 - Tong-il rice cultivation for African countries
 - Opportunities of international collaboration
- Keynote Speech by Prof. Junsuk Kang, Professor of Department of Landscape Architecture and Rural Systems Engineering, Seoul National University on 'Concept of 'Substitution' in Digital Agriculture Technology: Green Infrastructure to

- Supplement and Substitute for Vulnerable Agriculture Resources’
- Case of urban flooding the importance of water sewage systems
 - Consideration for water management in agricultural sector
- Keynote Speech and Presentation by Dr. Junghoon Lee, Chief Executive Officer, Telofarm, Inc. on ‘Microsensing and Data Processing Technology for Agriculture Industry and Future Generations and Case of Telofarm for Replacing Current Agriculture Technology’
- The phases of agricultural innovation through the human history and their implications: the story of Six Revolutions
 - Precision plat cultivation management solution by Telofarm and its benefits and outcomes
- Presentation by Prof. Hak-Jin Kim, Professor of Department of Biosystems Engineering, Director of BK21 Global Smart Farm Educational and Research Center, Seoul National University on ‘Case of RD&D Collaboration to Replace Current Agri-tect’
- The case of autonomous tractor developments
 - Potentials and challenges in implementing precision navigation systems for smart agriculture
- Keynote Speech by Prof. Kyeong-Hwan Lee, Professor of Department of Convergence Biosystems Engineering, Chonnam National University on ‘Inovative Digital Agriculture Technologies and Challenges’
- Progress of digital agriculture in Korea
 - Management of rice field using UAV
 - Precision navigation system solutions for apple farm management
- Keynote Speech by Dr. Mr. Jongkap Kim, Chief Executive Director, Born2Global Centre on ‘Building New Digital Agriculture Business Ecosystem and Policy Framework’
- The importance international business integration and joint venture development
 - Cases of digital agriculture business development through collaboration and joint-business framework in between Korea and other countries
- Presentation by Mr. Marc Dumas-Johansen, Agriculture and Food Security Specialist, Green Climate Fund (GCF) on ‘Climate Intelligence and Agricultural Resilience’
- GCF’s programs on agriculture
 - Climate information and early warning systems project cases

- Taking GCF pathway for investment funding
- Presentation by Mr. Andrey Chicherin, Head of Innovation, Technology Transfer and Co-Funding Platforms at the Private Sector Facility, Green Climate Fund (GCF) on 'GCF's RFP Approach to Support Business Incubation and Acceleration and Establishment of Ecosystems, Focusing on Agriculture'
- GCF's Request for Proposal approach and how to use it
- GCF's Request for Proposal processes
- Digital agriculture business incubation, acceleration and scale-up through GCF's RFP approach

Annex III – Idea boards of multi-country TA ideas

