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THE PROJECT ON SUSTAINABLE AND SMART AGRICULTURAL SUPPLY CHAINS DEVELOPMENT IN MEKONG COUNTRIES

END OF PROJECT EVALUATION REPORT

JUNE 2023

ACKNOWLEDGEMENT

The end of project evaluation was conducted by Mr. Quan Anh Nguyen, an independent Consultant, and enthusiastically supported and guided by Mr. Madhurjya Kumar Dutta, Director, Mr. Sa-nga Sattanun, Program Manager, Trade and Investment Facilitation (TIF) Department; Ms. Jutamas Thongcharoen, Program Manager, Agricultural Development and Commercialization (ADC) Department; Mr. Chakdao Sudsanguan, Program Facilitator, Sustainable Energy and Environment (SEE) Department, and Mr. Halimur Rahman, Monitoring, Evaluation and Learning (MEL) Specialist, Mekong Institute (MI), Thailand from April to June 2023.

The evaluation has received a strong support from the Project Advisory Committees (PAC) represented by Dr. Myo Nyein Aye, Deputy Director–General, Ministry of Transport and Communications (MoTC), Dr. Myo Min Thein, Director, Ministry of Electricity and Energy (MoEE), and Ms. Lin Lin Thi, Director, Ministry of Agriculture, Livestock, and Irrigation (MoALI) in Myanmar.

The evaluation has significantly benefited from feedback provided by the project beneficiaries and stakeholders participating in the four capacity development programs on Smart and Sustainable Farming Technologies, Food Loss Reduction, Smart Renewable Energy, and Smart Logistics Technologies, including trainings and action plan implementation in Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam, through the survey and key informant interview (KII) sessions.

The project evaluator would like to thank representatives of PAC, Mekong Institute (MI)'s Executive Director and Departments, and all stakeholders who have made significant contribution to the success of the project and the project evaluation as well.

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EXECUTIVE SUMMARY

The agriculture and the other sectors in the Mekong countries (Cambodia, Laos, Myanmar, Thailand, and Vietnam) were affected by the severe impact of COVID–19 pandemic and smallholder farmers and small and medium–sized enterprises (MSMEs)' access to smart technologies were constrained by various factors, including inadequate awareness of smart technologies applied in agriculture, energy, and logistic and transport sectors, and low capacities to adopt and deploy smart technologies in their productions and businesses duirng and post pandemic periods. In response to an increasing need for digital transformation to support the development of sustainable and smart agricultural supply chains in the Mekong region, Mekong Institute (MI) with the support from the Government of Republic of Korea through the Mekong–Korea Cooperation Fund (MKCF) designed and implemented the project on ***Sustainable and Smart Agricultural Supply Chains Development In Mekong Countries*** from December 2021–May 2023.

The project was implemented by three (03) departments, namely Agriculture Development and Commercialization Department (ADC), Sustainable Energy and Environment (SEE), Trade and Investment Facilitation (TIF), Mekong Institute (MI). It aimed to achieve the ultimate objectives of enhancing production effectiveness and efficiency, post–harvest loss reduction, and energy efficiency incresae in agricultural supply chains through cold chain development and smart and sustainable technologies deployed by the project beneficiaries and stakeholders in the Mekong countries in the long–run. In the short and medium terms, the project targeted the application of smart technologies and building capacity of relevant stakeholders on smart technologies upon its completion in 2023

The project intervention in the forms of (i) country situation analysis to assess capacity of the concerned stakeholders, identifying, and introducing compendia of smart technologies by sector to the project beneficiaries, and (ii) capacity development for the project beneficiaries from both public and private sectors. The project beneficiaries who have benefitted from the capacity development programs are required to disseminate the acquired knowledge and skills to indirect beneficiaries in the Mekong countries through localized training programs and associated formats, such as national workshops to raise awareness of smart technologies for public sector (government officials) and private sector (farmers and businesses), demonstrated projects to integrate smart technologies, improved curriculum at higher education program, public events, business and investment plans, and etc.

This end of project evaluation assesses the project performance over its 1½ year period. Specifically, the evaluation objectives are to:

- Assess the project results over its implementation period (Dec 2021–May 2023)
- Identify and document issues, challenges, experiences, lessons learnt, best practices, and success stories, or case studies from the project implementation
- Introduce compendia of smart technologies promoted by the project
- Prepare a policy brief to the Governments of Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam with a way forward to continued efforts on Sustainable and Smart Agricultural Supply Chains

The project is evaluated in alignment with with the OECD–DAC evaluation guidelines and criteria, namely, relevance, coherence, effectiveness, efficiency, sustainability, and impact which are supported by associated questions and justifications as specified in the evaluation framework and rating in Annexes 1 and 2 of this report. The end of project evaluation has followed a stepped approach consisting of four main phases:

FIGURE 1 - PROJECT EVALUATION BY PHASE

A a mixed–method approach comprising both qualitative and quantitative data collection methods was used for this project evaluation. Quantitative data was collected through the online survey and project filing system while qualitative data was received from key informant interviews (KIIs). Qualitative data was triangulated with quantitative data (numeric and measurable data) collected from the survey and desk review. This helped to increase validity of evaluation findings.

In line with the employed data collection methods, the Consultant through the support and coordination of MI's Departments in charge conducted:

- 01 survey with 103 project beneficiaries participating in the four (04) capacity development programs in April 2023. In early May 2023, the Consultant received the feedback from 38 respondents (36.8%).
- 04 group meetings to interview small groups of the project beneficiaries who implemented actions plans under the four (04) regional capacity development programs in the field countries such as Cambodia, Lao PDR, Myanmar, and Vietnam. Ten (10) people participated in the interviewed sessions.
- 01 group meeting to interview the Project Advisory Committee (PAC). Three representatives of the Ministries of Transport and Communications (MoTC), Electricity and Energy (MoEE), and Agriculture, Livestock, and Irrigation (MoALI) of Myanmar participated in the meeting.
- 01 group meeting with MI's Departments attended by 04 members representing ADC, SEE, TIF, and MEL, respectively.
- Information exchanged on the Consultants who conducted the country situation assessments for smart farming technologies, renewable energy, and logistics technologies in the Mekong countries. 03 Consultants were involved in this process.

Data collection process which started in early April 2023 and completed in early June 2023 is shown below.

TABLE 1-DATE COLLECTION PROCESS

Data Collection	Participants	Countries				
		Cambodia	Lao PDR	Myanmar	Thailand	Vietnam
01 Online Survey	38	10	07	11	01	09
04 Group meetings with project beneficiaries	10	01	01	03	0	05
01 Group meetings with PAC	03			03		
01 Group meetings with MI's Departments	04				04	
Information exchange with technical experts	02				02	
Total	**57**	**11**	**08**	**16**	**07**	**14**

The overall project performance is **successful** in accordance with the OCCE–DAC's evaluation criteria of relevance, coherence effectiveness, and efficiency. The project design and implementation is assessed **relevant** as it is consistent with needs and expectations of major beneficiaries. At a broader scope, the project is **coherent** with the global, regional, and national strategies and policies on sustainable agricultural development, energy efficiency, and smart and modernized logistics and transport infrastructure and services in support of agricultural supply chains in the Mekong countries. The project is rated **partly effective** in realizing most of the targeted short–term outcomes and outputs while it lacks an effective monitoring and evaluation (M&E) framework supported by specific targets and indicators for measuring the project's long–term results. On the other hand, the project is assessed **efficient** in terms of resource allocation and timely implementation.

The evaluation does not assess the project sustainability and impact in consideration of its nature–Human Resource Development (HDR) and timefarme that may not be sufficient to generate the long–term outcomes and significant impact. Instead, the evaluation discusses the possibilities for the project results

to be sustained and impact created in the post project completion period. As a result, the project is assessedd **likely to be sustainable** and **impactful** given the support and the involvement of the project beneficiaries and stakeholders, especially the ministries and agencies in the three sectors (agriculture, energy, and logistics and transport) in Myanmar. Significantly, Mekong Institute (MI) is expected to continue to expand the project to another phase to generate high–level results in future. At the same time, the project is perceived to achieve its intended impact on the continued reform in support of the sustainable and smart agricultural supply chains in the Mekong countries.

In parallel, the evaluation showcases the compendia of smart farming, renewable energy, and logistics technologies that can be applied by the project beneficiaries together with several case studies / business cases and the situation where these technologies, especially smart farming technologies have been harnessed, given the varied development levels of the agriculture sector in the Mekong region. To contribute to the project success in promoting smart technologies in support of the agricultural supply chain development in the Mekong countries, a policy brief on agricultural digitalization with solutions was proposed to the governments or public organizations for their consideration and actions required to facilitate the continued digital transformation process in an effective manner.

Lessons drawn from the evaluation

- An adequate project management structure, including M&E framework, targets, and indicators should be established at the project design stage and fully impemlented during the project cycle.
- A more effective coordination among MI's departments to get the project benefciaries involved in more than one capacity development program could widen the project results.
- Risks that may undermine project implementation, such as resource limitation and beneficiaries' readiness and capability to adopt, invest, apply, and deploy smart technologies in the three sectors, durinng and in post project completion period should be identified at the project design and mitigated during the project implementation, respectively.
- Capacity development programs need further improvements in terms of applied business models and best practices in line with business context of the Mekong countries to attract more private sector participants who can realize and apply the project results to their business activities.

Given these lessons, the project evaluation makes the following recommendations:

- Mekong Institute (MI) consider the next phase(s) of this project with an in–depth intervention through intensive capacity development programs and/or technical assistance to the beneficiaries in support of digital transformation in agriculture, energy, and logistics and transport sectors.
- The Mekong countries consider the recommendations under the Policy Brief as well as those suggested by the Country Situation Assessments to accelerate the agricultural digitalization process in the Mekong countries with successes.

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ACRONYMS

ABDP	Agricultural Big Data Platform
ADC	Agricultural Development and Commercialization Department
API	Action Plan Implementation
ASEAN	Association of Southeast Asian Nations
DAC	Development Assistance Committee
FGD	Focus Group Discussion
GMS	Greater Mekong Subregion
HDR	Human Resource Development
IoT	Internet of things
KII	Key Informant Interview
M&E	Monitoring and Evaluation
MI	Mekong Institute
MoALI	Ministry of Agriculture, Livestock, and Irrigation (Myanmar)
MoEE	Ministry of Electricity and Energy (Myanmar)
MoTC	Ministries of Transport and Communications (Myanmar)
MKCF	Mekong–Republic of Korea Cooperation Fund
MSME	Micro, Small and Medium–Sized Enterprise
OECD	The Organization for Economic Cooperation and Development
PAC	Project Advisory Committee
RoK	Government of the Republic of Korea
SDG	Sustainable Development Goal
SEE	Sustainable Energy and Environment
UAVs	Unmanned Aerial Vehicles
US$	United States Dollars

KEY PROJECT DATA

TABLE 2-PROJECT COSTS

Key Project Data (US$)	MKCF Grant proposed (US$)	Actual Amount approved (US$)
Total project cost	499,920	499,920
Total grant utilization	499,920	457,254 (as of May 2023)

TABLE 3-PROJECT KEY DATES

Key Dates	Expected	Actual
Grant Proposal	July 23-Agust 26, 2021	August 25, 2021
Grant Approval	September 16, 2021	October 26, 2021
Grant Effectiveness	December 1, 2021	December 1, 2021
Project Completion	May 31, 2023	June 13, 2023
Grant Closing	July 31, 2023	July 31, 2023
Months (Effectiveness to Completion)	1.5 years	1.7 years (Approved 1.5 year plus 2 months for report submission according to the agreement)

CHAPTER I. INTRODUCTION

A. Project Summary

The COVID–19 pandemic has exacerbated the underlying climate change impacts on food production. It has also expanded the exposed gaps between smallholder producers and Agri–food micro and small and medium–sized enterprises (MSMEs) and bigger producers and large–sized enterprises in access to smart technologies as well as skills to adopt and deploy smart and sustainable technologies in support the agricultural supply chains in the Mekong countries. The impact of COVID–19 has adversely imposed more challenges and difficulties on Agri–food businesses and more vulnerable groups, notably ineffective and inefficient production and productivity, product quality and postharvest losses, energy inefficiency, inappropriate logistics management and so on. Hence, there is an urgent need to transform agriculture supply chains (production, processing, and distribution) in the Mekong countries to application of the smart farming, renewable energy, and logistics technology, to contribute to the achievement of sustainable development goals (SDG) 2030, such as SDG 2–zero hunger, SDG 7–afforable and clean energy, and SDG 13–combating climate change, etc. These achievements will result in inclusive growth, building resilient society, and sustainable natural resources.

Mekong Institute (MI) started the project implementation in December 2021. The project summary and its implementation are described as below:

TABLE 4-PROJECT SUMMARY

Project Objectives

The objective is to enhance the competitiveness of Mekong countries by strengthening sustainable and smart production and distribution technologies in the agricultural supply chains in Mekong countries. More specifically, it aims to:

- Identify mechanisms for improving productivity and quality of agricultural produce
- Increase energy efficiency through using smart and sustainable technologies in agricultural supply chain
- Enhance agricultural supply chains by improving logistics systems including cold chain management practices for agricultural products in the Mekong region.

Project Outcomes

Short–term outcomes

- Application of smart technology in agricultural supply chains and energy used in selected agricultural products.
- Enhanced capacity of relevant stakeholder on technology utilization for agriculture supply chain.

Long–term outcomes

- Improved production effectiveness and efficiency.
- Reduction of postharvest losses in pilot agriculture products.
- Increased energy efficiency in agricultural supply chain.
- Adoption of smart and sustainable logistics technology in agriculture supply chain.

Project Components

- Sustainable and smart technology for agriculture production supply chain
- Energy efficiency in agriculture supply chain
- Smart logistics management for agriculture supply chain
- Monitoring and Evaluation

B. Project Implementation

The project is classified in three main components. Each compoment is implemented and managed by each of MI's thematic departments: (i) **Component A**: Sustainable and smart technology for agriculture production supply by Agriculture Developmemt and Commercilaization (ADC) Department; (ii) **Component B**: Energy efficiency in agriculture supply chain by Sustainable Energy and Environment (SEE) Department; (iii) **Component C**: Smart logistics management for agriculture supply chain by Trade and Investment Facilitation (TIF) Department; and (iv) **Component D**: Monitoring and Evaluation

TABLE 5-PROJECT IMPLEMENTATION

Designated Activities	Outputs	Timeline		Beneficiaries / Stakeholders
		Planned	Actual	
Inception	01 Inception Workshop with Project Advisory Committee (PAC) and Technical Working Group (TWG)	Dec 2021	Dec 09, 2021	32
Country Situation Assessment	01 Study on Smart Technologies in Agriculture Sector	Feb–Jun 2022	Dec 2022	188
	01 Study on Smart Renewable Energy Technology for Agricultural Supply Chains	Feb–May 2022	Mar–Sep 2022	20
	01 Study on Smart Logistics Technology Readiness for Agricultural Supply Chains		Mar–Aug 2022	18
Dissemination Workshop	01 Consultative workshop on Smart Farming Technologies	Jul–Aug 2022	Dec 6–7, 2022	89
	01 Workshop on Smart Logistics Technology and Smart Renewable Energy Technology	Jul 2022	Sep 06, 2022	29
Regional Training Program	01 Food Loss Reduction for Sustainable Value Chains	Dec 2022	Sep 12–16, 2022	24
	01 Sustainable and Smart Farming Technologies	Nov 2022	Sep 26–30,2022	24
	01 Smart Renewable Energy Technologies for Agriculture Supply Chain	Oct–Nov 2022	Nov 21–25, 2022	30
	01 Business Investment on Smart Logistics Technologies for Agricultural Supply Chain	Sep–Oct 2022	Oct 10–14, 2022	25
Action Plan Implementation (API)				
12 APs on Food Loss Reduction for Sustainable Value Chains:		Dec 2022 – Mar 2023	Oct 2022 – Mar 2023	882
14 APs on Sustainable and Smart Farming Technologies				561
05 APs on Smart Renewable Energy Technologies for Agriculture Supply Chains			Oct 2022 – Mar 2023	153
07 APs on Business Investment on Smart Logistics Technologies for Agricultural Supply Chain			Nov–Dec 2022	07
Synthesis and Evaluation Workshop				
03 APs on Food Loss Reduction for Sustainable Value Chain presented		Apr 2023	Mar 02–03, 2023	50
06 APs Sustainable and Smart Farming Technologies presented				
05 APs on Smart Renewable Energy Technologies for Agriculture Supply Chain presented				
04 APs on Business Investment on Smart Logistics Technologies for Agricultural Supply Chain presented				

Source: Mekong Institute (MI), Project reports, 2021–2023

CHAPTER II. PROJECT EVALUATION

A. Evaluation Criteria

The end of project evaluation is based on the OECD–DAC evaluation guidelines with the six core evaluation criteria (relevance, coherence, effectiveness, efficiency, sustainability, and impact).[1] The criteria and justification are adopted in an alignment with the nature of this project – human resoure development (HRD) project and shown in Table 6.

TABLE 6-EVALUATION CRITERIA AND JUSTIFICATIONS

Criteria	Justifications
Relevance	• The extent to which project design and support is perceived as relevant to the needs of the project beneficiaries (direct and indirect) and/or stakeholders in agriculture, energy, and logistics and transport sectors in the Mekong countries in terms of institutional and individual skill and competency; and the project objectives
Coherence	• The extent to which the project intervention aligned with and supplemented the Mekong governments' sustainable agricultural development policies and/or initiatives, and the project beneficiaries' organizations in both public and private sectors on promoting smart and sustainable technologies to reduce post–harvest losses, increase energy efficiency, and adopt cold chain development and smart logistic technologies
Effectiveness	• The extent to which the project intervention contributed to the project beneficiaries in terms of achieving its goals and results based on the quality of the project implementation approaches and strategies, project management, and M&E processes: (i) actual activities and results compared with project planning; (ii) monitoring and evaluation (M&E) framework; (iii) successes, challenges, and lesson learnt; and (iv) and beneficiaries' participation
Efficiency	• The extent to which the project intervention delivers, or is likely to deliver results in efficiency within the project timeframe
Sustainability	• The degree to which the project long–term outcomes is perceived as sustainable by different stakeholders; and level of capacity and preparation by the project beneficiaries and stakeholders towards sustainability
Impact	• The likely impact on the project beneficiaries' knowledge and practices for contributing to agricultural productivity and quality and economic competitiveness led by green and smart agricultural supply chains in the Mekong countries

Considering the project implementation within a 1½ year period (December 1, 2021–May 31, 2023), the evaluation focuses on the project performance through its activities, outputs, and short–term outcomes in accordance with the reported project results and recent data collection through KIIs and questionnaire survey with MI's departments as the project implementors, Project Advisory Committee (PAC) members, and the capacity development programs participants as the project beneficiaries from April–early June 2023. The project's long–term outcomes and impact may need a longer implementation period to measure. As such, the project sustainability and impact are discussed in line with the perspectives and expectations of the project implementors, beneficiaries, and stakeholders, respectively.

B. Overall assessment

Overall, the project is rated **successful**. The overall assessment is based on equally weighted individual assessment criteria: relevance, coherence, effectiveness, efficiency (Table 7). As mentioned, such criteria as

[1] https://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm#

sustainability and impact are just discussed but not assessed because of the project nature and its short implementation period that result in difficulties in precise attribution and quantification.

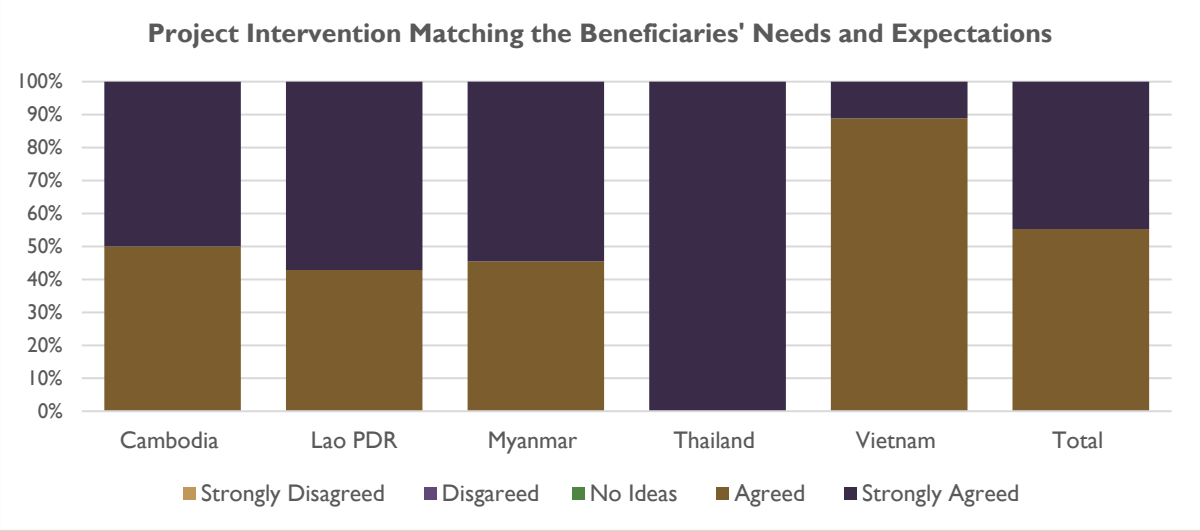
TABLE 7-ASSESSMENT OF PROJECT PERFORMANCE

Criterion	Weight (%)	Assessment Result
Relevance	25	Relevant
Coherence	25	Coherent
Effectiveness	25	Partly Effective
Efficiency	25	Efficient
Sustainability		Likely to be sustainable
Impact		Likely to be impactful
Overall Rating	100	Successful

C. Relevance

The project is assessed **relevant**. The project capacity development programs were designed in line with the country situation assessments on (i) smart technologies in agriculture sector, (ii) smart renewable energy technologies, and (iii) smart logistics technology readiness for agricultural supply chains that were conducted in consultation with relevant stakeholders from both public and private sectors in five Mekong countries (Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam) in 2022. The introduction of smart technologies with cost and benefit analyses and associated recommendations were accordingly validated with the concerned stakeholders in 2022. At the same time, the participation of the project beneficiaries in all capacity development programs is subject to MI' selection criteria, namely, educational background, professional interests, job sectors, roles, and responsibilities, working experiences, and future plans upon completion of the capacity development programs. According to the project reports and the results of the online interviews and survey, the project fits with the needs of its beneficiaries' capacity development as shown in Figure 2.

FIGURE 2-PROJECT INTERVENTION MATCHING THE BENEFICIARIES' NEEDS AND EXPECTATIONS OF CAPACITY DEVELOPMENT



However, the project design is not fully relevant to its objectives. The project intervention through capacity development and introduction and promoting smart and sustainable technologies., i.e., farming technologies, renewable energy, logistics technologies, may not be adequate to "enhance the competitiveness of the Mekong countries by strengthening sustainable and smart production and distribution technologies in the agricultural supply chains…" with the fact that there is no result recorded and proven. In addition, the project underestimated the risks entailed from design to implementation stages

in terms of resource limitation and beneficiaries' readiness and capability to adopt, invest, and apply or advance smart and sustainable technologies in the three intervened sectors. These risks may affect the project implementation to achieve its long–term outcomes.

D. Coherence

The project is assessed **coherent**. The project development is in full compliance with the Government of the Republic of Korea (RoK)'s partnership strategies with the Government of the Mekong countries (Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam) through Mekong–RoK Cooperation Fund (MKCF) [2] in support of catalytic and innovative activities in the priority sectors, namely, human resources development in connection with agriculture and rural development. Particularly, the project intervened in strengthening regional agricultural supply chains, agricultural productivity improvement, and digitalization of rural transformation for agricultural development in the Mekong region.

The project is aligned with the Mekong Institute's Strategic Plan for 2021–2025 [3] where its development focus consists of sustainable agricultural development, green freight and logistics development, energy connectivity, renewable energy, and energy efficiency. Importantly, the project design and implementation is coherent with the Mekong countries' growing attention to smart and sustainable agriculture development through the following strategies and policies at different levels:

- United Nations (UNs)' Sustainable Development Goals (SDGs) 2030 on food systems, e.g., SDG 2–Zero hunger, SDG 6–Sustainable water management, SDG 7–Affordable and clean energy, SDG 11–Sustainable cities and communities, SDG 13–GHG emission reduction
- Responsible Investment in Food, Agriculture, and Forestry in ASEAN [4]
- Greater Mekong Subregion Sustainable Agriculture and Food Security Program [5]
- Thailand's 20–year Agriculture and Cooperatives Strategies (2017–2036) with vision for smart farming in the country [6]
- Cambodia's Agricultural Sector Master Plan 2030 (ASMP 2030) on development of a competitive, inclusive, resilient, and sustainable modern agriculture sector [7]
- Lao PDR's Agriculture Development Strategy to 2025 and vision to 2030 on food security, producing comparative and competitive agricultural commodities, developing clean, safe, and sustainable agriculture and modernization of a resilient and productive agriculture economy. [8]
- Myanmar Climate Smart Agriculture Strategy, 2015 [9]
- Viet Nam's Strategy on Sustainable Agriculture and Rural Development in 2021–2030 period and the vision to 2050" with a focus on agricultural digitalization as the most important solutions [10]

At the organizational and individual levels, the interviewed and surveyed beneficiaries and stakeholders have agreed on an alignment between the project design and intervention and the countries' policies as well as their organizations' initiatives and/or projects as shown in Figure 3. However, few stakeholders found no coherence (Myanmar and Vietnam) and had no ideas about the project coherence ((Lao PDR, Myanmar, and Vietnam). It was also noted that the regional intervention by this HDR project did not directly fit with the strategies and priorities in each of the Mekong countries.

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2 https://www.mekonginstitute.org/fileadmin/user_upload/Mekong_Institute/News/2023/TIF/3._MKCF_Management_Manual_Ver3.0_2023_Apr.pdf

3 https://www.mekonginstitute.org/uploads/tx_ffpublication/MI_Strategic_Plan_Infographic.pdf

4 https://docs.wixstatic.com/ugd/4458b1_72f0553231b14209a4195dff8466b845.pdf

5 https://greatermekong.org/g/agriculture#:~:text=Agriculture%20is%20the%20backbone%20of,of%20nearly%20200%20million%20people.

6 http://www.oae.go.th/assets/portals/1/files/bapp/strategic20year_eng.pdf

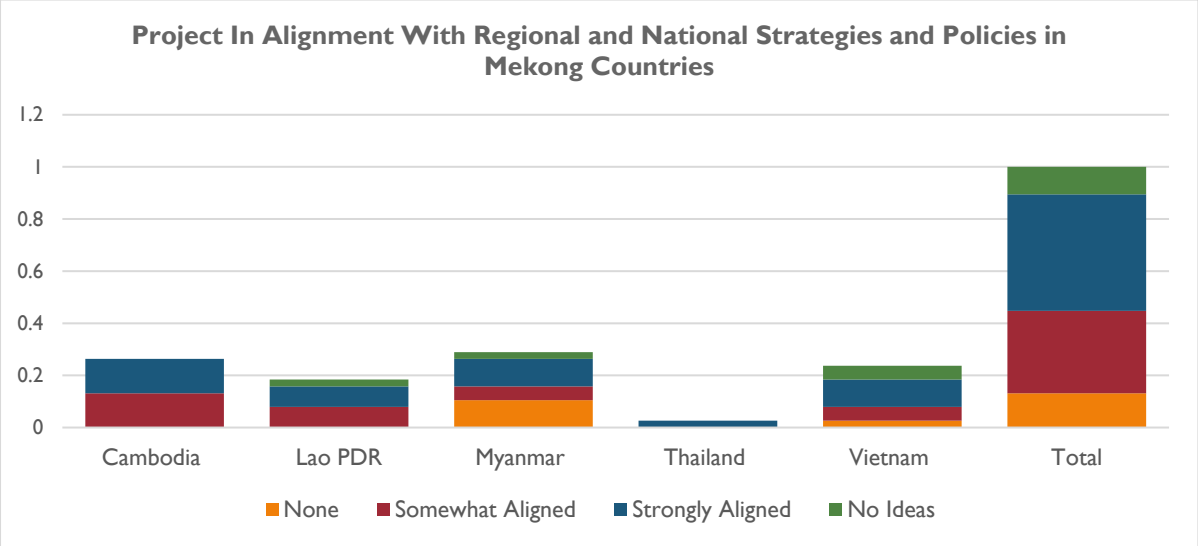
7 https://web.maff.gov.kh/documents/gQMqjQBOBX?lang=en

8 https://www.maf.gov.la/wp-content/uploads/2016/01/MDS-2025-and-Vision-to-2030-Eng.pdf

9 https://ccafs.cgiar.org/resources/publications/ccafs-helps-establish-framework-myanmars-policies-programs-and

10 https://ipsard.gov.vn/Strategy-Guidelines/index.html

FIGURE 3-PROJECT COHERENCE BY BENEFICIARIES' PERSPECTIVES



E. Effectiveness

The project is rated **partly effective**. According to the project reports, interviewed stakeholders and project implementors, the most effective outputs and short–term outcomes of the project include:

- Assessments of the Mekong countries' capacity needs and identifications of smart technologies by category and sector, and potentials for technological adoption
- Design and delivery of four (04) capacity development programs and promotion of smart technologies by sector agriculture, energy, and logistics and transportation, to its beneficiaries consisting of 103 direct beneficiaries, accounting for 95.4% as compared with 108 participants (100%) as proposed.
- Increased awareness, skills, and knowledge of smart farming, renewable, and logistics technologies
- The Action Plan Implementation (API) by the project beneficiaries in different forms, includes the following:
    - Localized capacity development programs to distribute knowledge sharing of smart technologies and practices to the local beneficiaries (indirect beneficiaries)
    - Public events, e.g., national workshops, seminars, to raise awareness and call for the attention from both public and private sectors
    - Formalized educational program where smart technologies is the subject at higher education program
    - Established smart technology demonstration farms, laboratories, and working groups
    - Demonstrated projects
    - Business plans for investment and financing smart logistics technologies
    - Stakeholder engagement with established coordination and collaboration networks in which 1600 indirect beneficiaries benefitted from API and more than 200 stakeholders participating in country assessments.

In addition, the interviewed and surveyed project beneficiaries found themselves effective in contribution to the success of the capacity development programs which were regarded as good and excellent. They also agreed that all capacity development programs were successful, and the project achieved the designated outputs and short–term outcomes as reflected in Figures 4, 5, and 6, respectively.

FIGURE 4-PROJECT BENEFICIARIES' EFFECTIVENESS IN CONTRIBUTION TO CAPACITY DEVELOPMENT PROGRAMS

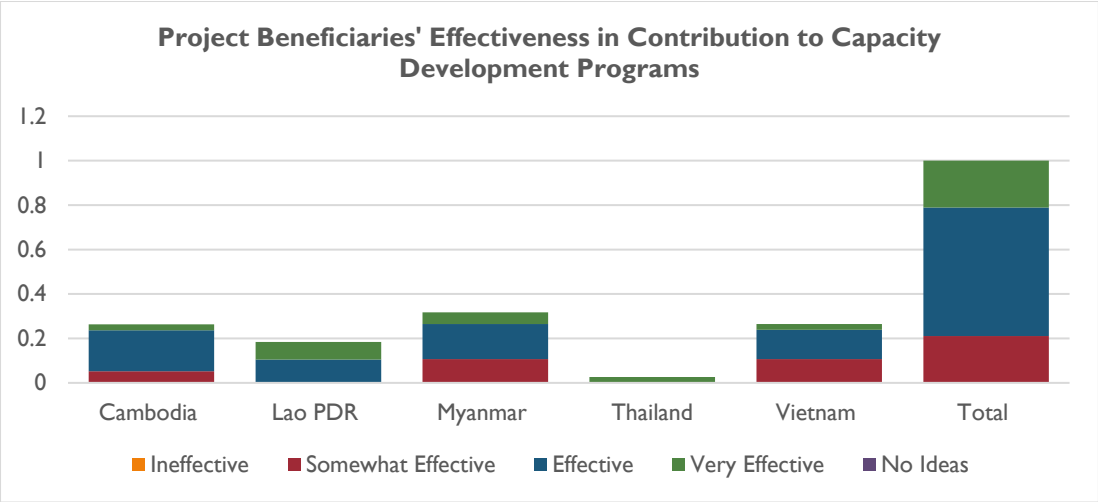


FIGURE 5-OVERALL ASSESSMENT OF PROJECT CAPACITY DEVELOPMENT PROGRAMS

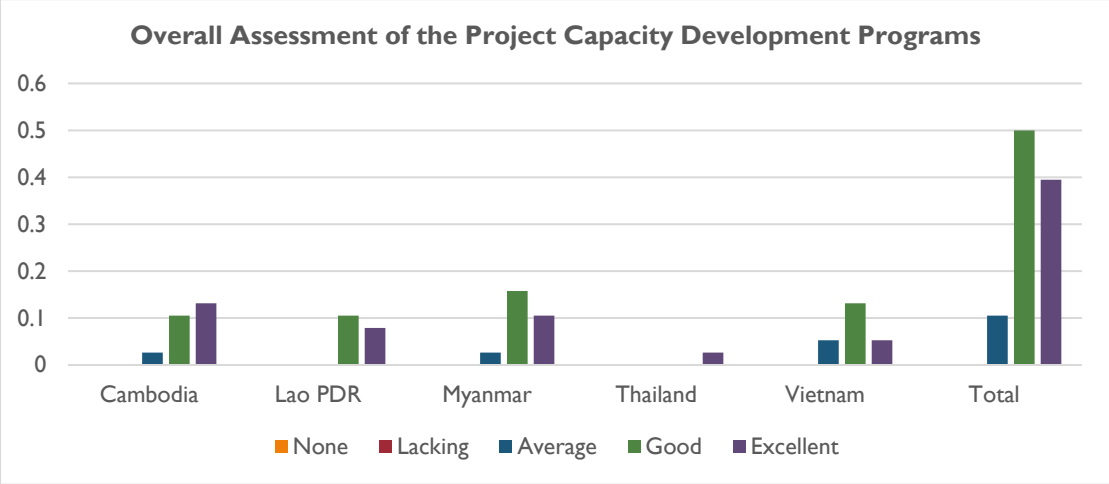
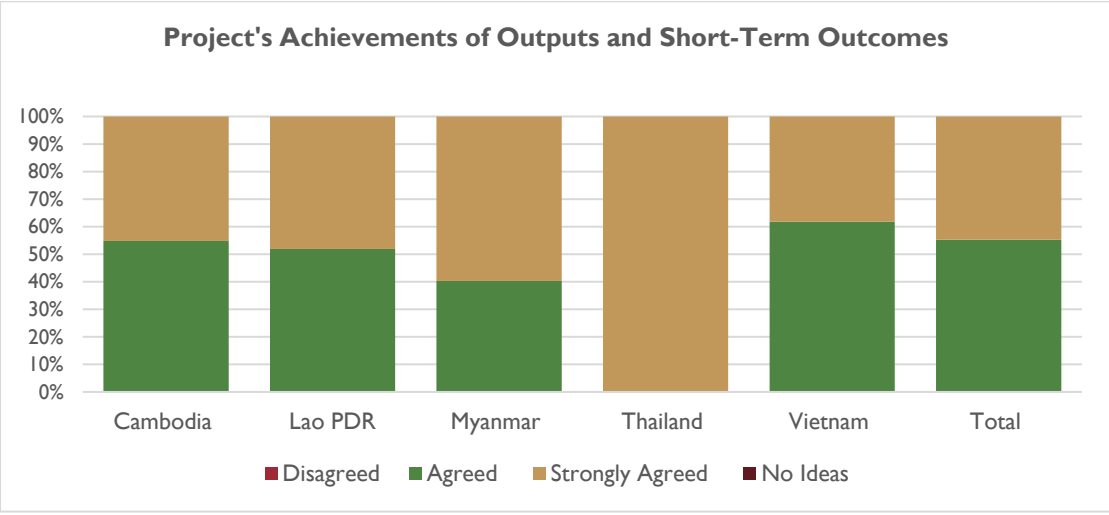


FIGURE 6-PROJECT'S ACHIEVEMENTS OF OUTPUTS AND SHORT-TERM OUTCOMES



Despite the successful factors contributing the project effectiveness, the project did not establish a monitoring and evaluation (M&E) framework with specific targets and indicators for measurement of the project results during its implementation period. The project outputs and short–term outcomes were monitored, but an effective M&E mechanism to support the country–wise action plan implementation and the long–term outcome is lacking. For this reason, it is challenging for the project implementors to obtain accurate information from indirect beneficiaries and understand how the project results can be sustained upon the project completion.

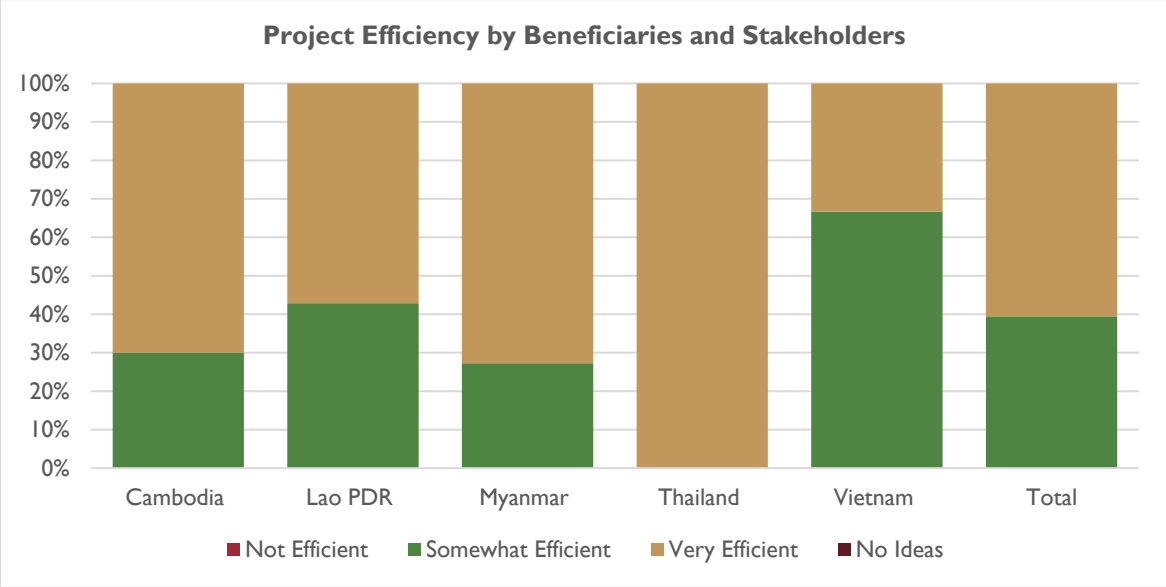
E. Efficiency

The project is rated **efficient**. According to the project's financial data, the project disbursement reached to 91.46% as of May 2023. The project resources were allocated by component and implemented to deliver the project activities and outputs, including budget arrangement to facilitate the implementation of the action plans by the project beneficiaries, in compliance with the budget structure approved by MKCF and MKCF's operations guidance on project management and MI's policies, including financial management and procurement procedures.

By timeline, the implementation progress matched and exceeded its planning within the project timeframe (Dec 1, 2021–May 31, 2023), i.e., most project activities and deliverables were implemented and completed in a timely manner.

By implementation arrangement, the project provided the project beneficiaries with both onsite and online training programs. The online training model adopted by SEE and TIF Departments could help in economizing the project costs while the quality of capacity development programs could remain the same as the onsite trainings. This also gave the participants more flexibility to manage and balance their work and training attendance.

FIGURE 7-PROJECT EFFICIENCY BY BENEFICIARIES AND STAKEHOLDERS' PERSPECTIVES



The interviewed and survey stakeholders and beneficiaries agreed that the project through all capacity development programs was efficient in terms of appropriate timeline and associated coordination supporting their participation and completion of required tasks as shown in Figure 7.

However, the budget allocation for the beneficiaries to implement action plans is not consistent in all MI's Departments as the project implementors. Importantly, the quality of all action plans should have been properly monitored and evaluated to ensure cost efficiency and cost effectiveness.

CHAPTER III. OTHER ASSESSMENTS

A. Sustainability

The project is likely to be **sustainable**. Although the action plan implementation (API) results under the components A and B did not bring in results in terms of (i) improved production effectiveness and efficiency; (ii) reduced postharvest losses in pilot agriculture products; and (iii) increased energy efficiency in agricultural supply chains at the project closure, most surveyed project beneficiaries believed that the project could achieve its long–term outcomes. At the same time, the project beneficiaries, especially those who implemented action plans, found it challenging to sustain their activities in the field countries to promote smart farming technologies and smart renewable energy technologies without technical and policy support from their own countries. From logistics and transportation perspectives, the development of business plans for investments in smart logistics technologies by private logistics companies showed their interests and willingness to modernize their businesses, including support of the development of agricultural supply chains in the Mekong countries. However, adoption of smart logistic technologies and investments require an enormous effort of the project beneficiaries under this project framework. There exist certain constraints, including banking finance, national policy instruments, market conditions, etc., facing their moving forward with business transformation from now on.

Notably, the project influenced the thinking of the project beneficiaries and stakeholders from the government ministries and agencies in agriculture, energy, and logistics and transport sectors, especially in Myanmar, on promoting and mainstreaming smart technologies in the Mekong countries. The interviewed stakeholders suggested that the project results be maintained and sustained after this phase where the project is successful at building knowledge and awareness of adopting smart technologies for its beneficiaries and stakeholders.

B. Impact

The project is likely to be **impactful**. The interviewed and surveyed beneficiaries and stakeholders perceived that the project plays an important role in promoting smart technologies for both upstream and downstream actors in agriculral supply chains in the Mekong countries. All claimed that the application of smart technologies contributes to sustainable development supported by positive environmental or social impact. Indeed, a pathway beyond the project timefarme is needed for businesses, especially MSMSEs and farmers to enhance product quality, manage business activities and associated costs, and optimize their resources from which agricultural productivity and quality and economic competitiveness led by green and smart agricultural supply chains in the Mekong countries can be enhanced.

CHAPTER IV. INTRODUCTION OF SMART TECHNOLOGIES AND CASE STUDIES

Mekong Institute (MI) through this project has introduced and promoted digital innovations in agriculture, energy, and logistics and transport sectors to its stakeholders and beneficiaries the Mekong countries during the project implementation period. The compendia of smart and sustainable technologies were studied in the country assessments and introduced to the project beneficiaries and stakeholders and summarized as below.

A. Smart Farming Technologies

TABLE 8-SMART FARMING TECHNOLOGIES

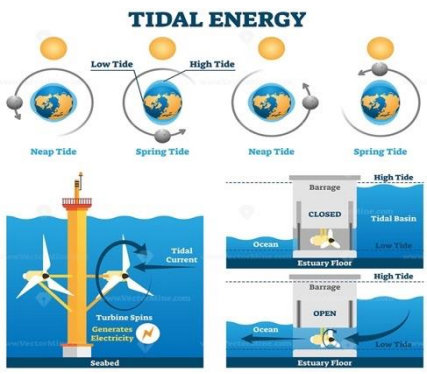
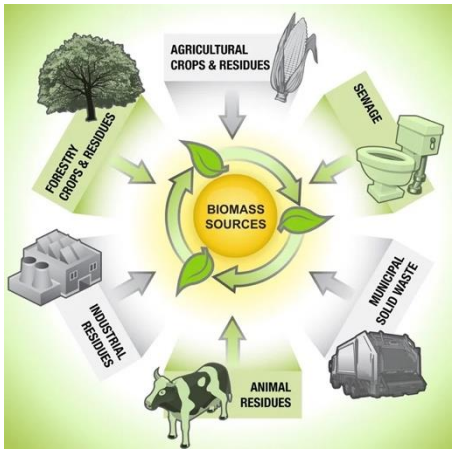
Smart Farming Technologies	Description
Agricultural Drones 	Drones also known as Unmanned Aerial Vehicles (UAVs)–multipurpose flying robotic vehicles that can be operated by an operator from the ground or can work autonomously based on a predetermined algorithm. Drone technology has many applications and in various agricultural activities. The drones are applicable and useful in multiple ways, including, soil analysis for field planning, plant establishment, precision application of agrochemicals, crop monitoring, irrigation management, crop health assessment, livestock monitoring, and disaster management, geo–fencing, crop biomass and damage estimation, locust control, and transporting goods in agriculture. Overall, drone technology is rapidly emerging technology thanks to its diverse applications. Drones not only improve the overall performance in agriculture but also motivate farmers to adopt precision agricultural practices and provide opportunity to transform farming from labor intensive to technology intensive profession. It reduces human errors and inefficiencies in conventional agricultural practices by providing accurate and reliable information about situation on agricultural field. The combination of software, sensors, camera, and different analytical tools can autonomously capture and interpret the data and images to actionable information and insights which helps in reducing the human error at large extent.
Internet of things (IoT) 	***Smart greenhouses***. IoT sensors can control every aspect of greenhouse operations, from lighting, irrigation, and fertilization to pest control and air humidity. This greatly increases the chances of timely identification and correcting any fluctuations, keeping growth conditions optimal for plants, and ensuring good harvests. ***Drone monitoring.*** Modern drones like Sense Fly can perform a wide range of functions, from geospatial data collection and soil analysis to plant fertilization control or pest spraying. Helping small farmers cultivate their fields, drones are among the most promising directions for the future of agriculture.

	Equipment monitoring. Every farm has to rely on a wide variety of equipment, from water pumps and engines to solar panels. All of this equipment needs maintenance, as having any system shut down during harvest season can lead to significant losses. Powering preventive maintenance with IoT technology allows farmers to optimize the service cycles of their equipment and prevent unexpected system failures. ***Precision farming.*** An IoT-based intelligent agriculture field monitoring system with soil sensors helps track the humidity or chemical characteristics of the soil or signal pest infestation. This enables farmers to optimize the use of water and fertilizers, as well as quickly shutting down pests to improve crop yields.

B. Smart Renewable Energy Technologies

TABLE 9-SMART RENEWABLE ENERGY TECHNOLOGIES

Smart Renewable Energy Technologies	Description
Smart Solar Roof Technology 	Solar energy is created via a photovoltaic system, where panels generate electricity through exposure to sunlight. This electricity is converted from DC (direct current) to AC (alternating current) power and supplied back to the power grid or stored for later use. By installing solar rooftop panels on industrial and commercial buildings, businesses can take advantage of larger surface areas to generate electricity from sunlight, while supplying excess energy back to the power grid. Agricultural warehouses with large roof space can benefit from installing solar rooftop panels for energy efficiency.
Wind Power Technology 	The force of the wind can be converted into mechanical or electrical power. A wind turbine works by catching the energy in the wind, using it to turn blades, and converting the energy to electricity through a generator in the part of the turbine called a nacelle. For systems with battery backup, batteries will store the power. An inverter will convert direct current (DC) electricity to alternating current (AC). Small scale wind turbines are capable of producing up to 100 kW.
Tidal Hydrokinetic Energy	Energy is generated by the movement of a body of water. Hydrokinetic projects generate electricity directly from the flow of water in rivers, inland waterways, irrigation canals, tides, rivers, canals, and ocean currents, and other man-made conduits. The tidal hydrokinetic energy is environmentally friendly, which can help to reduce harmful greenhouse gas emissions. The technology harnesses tidal energy from low-speed tidal flows ranging from 0.6m/s to 2m/s, even in shallow waters. This offers a largely untapped market for these turbines that are targeted at the non-utility sector, such as off-grid islands, fast streams, rivers, irrigation

	canals, and under bridges. The uses also lend themselves to aquaculture where they can be useful sources of energy for lighting, pumps, feeding, aeration, desalination, cleaning, refrigeration, monitoring, and supporting (barge) operations.
Electric Forklift for Agricultural Warehouse 	Operationalizing Electric forklifts do not need any modifications to the existing warehouse. Only electric power is required to charge the forklift (an AC power port to plug in the charging) and a spare battery that sits on the charge. Compared to fossil fuel powered trucks, electric forklifts are equipped with a host of ergonomic and safety features. Electric forklifts enable high productivity combined with energy efficiency that lower operating costs and increase profits. They are also much smoother and quieter than diesel powered forklifts
Biomass energy 	Biogas is produced after organic materials (plant and animal products) are broken down by bacteria in an oxygen-free environment, a process called anaerobic digestion. Biogas systems use anaerobic digestion to recycle these organic materials, turning them into biogas, which contains both energy (gas), and valuable soil products (liquids and solids). Biogas can also be upgraded into biomethane, also called renewable natural gas or RNG, and injected into natural gas pipelines. It can even be used as a vehicle fuel after it is converted to Compressed Natural Gas (CNG) or Liquefied Natural Gas (LNG).

C. Smart Logistics Technologies

TABLE 10-SMART LOGISTICS TECHNOLOGIES

Smart Logistics Technologies	Description
Liquid Nitrogen Quick Freezer	A cryogenic fluid that boils at –196c (–321F) causing rapid cooling. Conventional freezing can destroy the cells and structure of food products due to the formation of large ice crystals. Rapid freezing with Liquid Nitrogen results in

	the formation of smaller ice crystals, ensuring that the moisture quantity in foods is maintained for longer. Liquid nitrogen quick-freezing technology can be used to quick-freeze fruits and vegetables. Due to the short dehydration time of foods, the water can quickly pass
Smart Reefer Containers 	Suitable for goods that need to be temperature controlled. The container is designed to maintain its temperature, humidity, and atmosphere at a constant value during the whole transit time. It's used for transporting chilled and frozen goods–commodities such as fruit and vegetables, meat, fish, poultry, and dairy products. Smart Reefer containers are designed to reduce food wastages due to the perishability of fresh food products and the special requirements for ambient temperatures
Warehouse Drones 	An unmanned aerial vehicle with computer vision (AI–enabled) that are able to detect and count inventory with an accuracy of 99.9%, much higher than manual checking. They can be integrated to any warehouse setting and can count almost any type of inventory. The operationalization does not require any additional infrastructure in the warehouse.
Autonomous Mobile Forklift (AMF) 	A type of robotic driverless forklift. Autonomously driven forklifts are disrupting the material handling industry. It offers a reliable solution to help optimize workflow, provide flexibility, and help achieve significant cost savings by picking up, transporting, and dropping off pallets at the desired destinations in the warehouse or production center without human intervention.
Autonomous Mobile Robot Base 	A fully autonomous robot that provides a safe and cost–effective effective solution to accelerate warehouse process automation. It is programmed to perform repetitive, non–value–added tasks such as moving materials autonomously to various locations. It moves heavy payloads quickly through demanding environments without compromising safety. AMRB's are operated by rechargeable, environmentally friendly electric battery power

Multipurpose Autonomous Patrol Robots + Thermal Imaging (Solution).	Robots can be programmed to patrol a set scheduled route or sent on ad–hoc missions, while avoiding obstacles using 3D scanning technology. Cameras mounted on the patrol robots can discern subtle colour differences in fruit and vegetables (and other products) in the visual spectrum. Laser light sources enable quality categorizing according to color, structure and biological characteristics. They can also detect and remove contaminants that may have the same visual appearance as regular food items, especially when sorting fruit and vegetables that have varying degrees of freshness and product consistency.

D. Harnessing smart and sustainable technologies in the Mekong countries

Agriculture is the key sector in the Mekong countries. However, its development has encountered critical challenges facing economic value of crops and sustainability caused by natural disasters, climate change, exploitation of natural resources, etc., leading to forest and biodiversity loss, water pollution and shortages, soil degradation, and greenhouse gas (GHG) emissions. For these reasons, the Mekong countries' governments and their people have strategized and prioritized sustainable agriculture practices in parallel with increasing the productivity and profitability of agriculture, particularly for small–scale producers and farmers. [11]

Sustainable agriculture lies on a delicate balance of maximizing crop productivity and maintaining economic stability while minimizing the utilization of natural resources, including non–renewable resources, and detrimental environmental impacts. Such environmental damages can be mitigated by the promotion of renewable resources such as solar, wind, biomass, tidal, geo–thermal, small–scale hydro, biofuels, and wave–generated power. Renewable energy in farming production connects all aspects of agronomy with ecology, environment, economics, and societal change. These renewable resources have a huge potential for the agriculture sector. Hence, use of renewable energy systems for sustainable agriculture, e.g., solar photovoltaic water pumps and electricity, greenhouse technologies, solar dryers for post–harvest processing, and solar hot water heaters has been prioritized many countries, including the Mekong region.

The quality of raw crops depends upon the time factor. Keeping crops in storage in a long period may decrease the nutrition value while increasing the overall costs. As such, the optimal solution is to distribute agricultural product to the market in a timely manner. This can only be possible if the logistic system is upgraded and can handle the real–time requirements of agriculture product transport. Therefore, application of smart logistics technologies, such as IoT–based logistics, will benefit farmers and the other actors in agricultural supply chains in terms of increased revenue and improved quality of crops. The development of Internet of Things (IoT), advance artificial intelligence system, e–commerce has driven a transformation in logistic services.

As a matter of fact, smart logistics have attracted many big agricultural industry–based players' investments from global to national level. This necessitates agricultural industrialization and the application of new technology to modernize the agricultural process. Smart logistic systems contribute to increasing the food safety, productivity, and the quality of farm products as the key factor. Thus, smart logistics for sustainable agriculture is expected to own such qualities as (i) smart logistics technologies; (ii) faster deliveries; (iii) lower or competitive logistics and transportation costs; (iv) traceability with accurate locations; and (v) demand–driven services.

In the agriculture sector, Cambodia, Myanmar, Thailand, and Vietnam have prepared to adopted / have adopted and deployed different types of farming technologies with the support of the national policies and

[11] https://greatermekong.org/g/agriculture#:~:text=Agriculture%20is%20the%20backbone%20of,of%20nearly%20200%20million%20people.

public funding, the growth of innovative (AgriTech) startups, and research centers in recent years. In Thailand, the widely used farming technologies include (i) drones for precision agriculture; (ii) smart greenhouses; (iii) agriculture apps; and (iv) artificial intelligence (AI). [12] In Vietnam, several smart farming models have been developed, such as (i) smart hydroponic vegetable growing model, (ii) pesticide spraying drones remotely controlled, (iii) smart water management solutions; (iv) traceability from farm to table with blockchain technology, etc. [13] In Cambodia, the farmers have been looking for innovative solutions that can increase yields and productivity, such as drone technology for spraying pesticides, automating irrigation with remote control by mobile phones. At the same time, internet of things (IoT) and machine learning in transforming farm management, especially in areas such as disease detection, irrigation planning, yield prediction, water management, livestock management and weather forecasting have been studied. Significantly, Cambodia has seen enormous potential in leveraging Big Data. CamAgriMarket mobile application in March 2021, which will connect producers, brokers, and consumers on a single platform to facilitate transactions. At the same time, the country's Agricultural Big Data Platform (ABDP) has been established. [14] In Myanmar, many farmers lack critical information needed to maximize their farming yield. According to the World Bank's data, agricultural productivity is rather low–a rice farmer in Myanmar only generate 23 kg of paddy after one working day during the monsoon season while Vietnam's output is 429 kgs, Thailand's is 547 kgs, and Cambodia's 62 kgs, respectively.[15] The establishment of Agri–Tech startups have been helping farmers capitalize on their unfulfilled potentials given the increase in use of telecommunication in the rural farming areas. For instance, Tun Yat is the first tech–enabled tractor and harvester rental service platform in Myanmar connecting growers with harvesting machine owners. There are also apps linking registered farmers with agronomists to solve farming issues. [16]

However, the adoption and application of smart technologies in the Mekong countries have still been encountering certain challenges. According to Grow Asia, established by the World Economic Forum (WEF) and the ASEAN Secretariat, only 2.5% of 71 million smallholders in ASEAN have utilized 60 of the world's leading digital solutions for agriculture.[17] The challenges exists in situations where (i) farming households are small with low investment capital capacity are dominant; (ii) cooperation and association among agricultural producers/farmers are weak; (iii) farmers run small–scale production and rely more on middlemen in the agricultural supply chains; (iv) inadequate information technology infrastructure in the rural areas that cannot meet the requirements of smart technologies; (v) digital governance models to design suitable software platforms in line with the value chains' needs is lacking; (vi) market of agricultural machineries and equipment is underdeveloped and the automation rate in agriculture is low; (vi) regulations and standards for smart agriculture cannot meet production requirements and market dynamics; and (vii) supporting mechanisms and policies in support of smart agriculture development are not effective or not yet in place.

E. Business cases on adoption of smart and sustainable technologies

Business Case 1. Investment in Warehouse Business with Drone Technology by Lien Chieu Logistics Company (GLCC), Vietnam

Green Lien Chieu Logistics JSC is located in Da Nang Industrial Zone in proximity to Da Nang Hi–Tech Park and managed by Mr. To Van Hiep, Chief Executive Officer (CEO). The company is now developing a smart warehouse business project with use of drone technology right in Da Nang Hi–Tech Park.

[12] https://www.boi.go.th/upload/content/TIR7_Aw_Smart%20farming_5e5dc88fa8284.pdf

[13] https://ap.fftc.org.tw/system/files/journal_article/Smart%20agriculture%20for%20small%20farms%20in%20Vietnam%20Opportunities%2C%20challenges%20and%20policy%20solutions_0.pdf

[14] https://www.aseantoday.com/2020/09/how-cambodia-can-revive-agriculture-with-big-data/

[15] https://blogs.worldbank.org/eastasiapacific/unleashing-myanmar-agricultural-potential

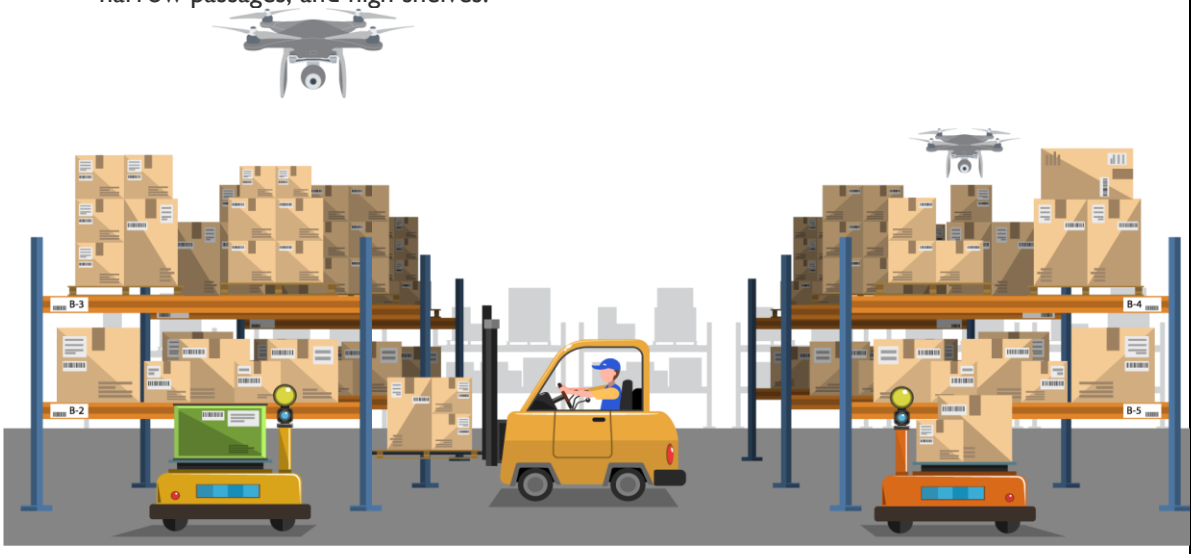
[16] https://techwireasia.com/2020/06/how-agritech-solutions-are-shaping-myanmars-digital-economy/

[17] Ibid

By size, the company's warehouse project covers an area of 3,500 m^2 located in the Logistic Center (40,000 m^2), consisting of three (03) warehouses and one container depot. This is the phase–1 investment project as part of its business expansion in addition to its core transport services.

Investing in smart warehouse system, the company's drone technology is used as an effective solution to (i) improve cycle counts; (ii) optimize operations costs; (iii) secure labor safety; (iv) enhance stock searching; and (v) advance surveillance. To this end, the company has considered the following functions of warehouse drone under this business project:

- Inventory audit. Scanning item barcodes and radio frequency identification (RFID) tags to calculate item quantities and record locations.
- Warehouse capacity calculations. Collecting data about the number and locations of empty slots in real time that allows warehouse workers to efficiently store and ship items.
- Item tracking. Adding the exact location of each item to the warehouse database so it can find any box fast and easily.
- Video surveillance. Making warehouse surveillance more flexible and comprehensive, improving warehouse security.
- Remotely controlled physical manipulations. UAVs built specifically for working in warehouses can lift and shift lightweight objects. UAVs can also work in dangerous environments, such as narrow passages, and high shelves.



With the expansion to warehouse business, the company has set the target to increase the market segments in Vietnam and neighborhood countries, e.g., Lao PDR, and increase the number of clients to 100 clients, including those doing business in agriculture sectors. The commodities that are managed by the company's warehouse system include agricultural products, namely rice, cassava, corn, animal feed, sugar, and bananas.

The company warehouse with use of drone technology will start in 2024.

Investment and projected profit:

- Initial investment cost: US$ 35,149
- Annual profit–to–sales ratio: 16%
- Payback period: 02 years

After this phase, the company will consider investing in the other smart logistics technologies for warehouse businesses that is subject to market demand and supply chain development and requirements.

Business Case 2. Solar Water Pump for Irrigation of Smallholder Farmers in Batheay District, Kampong Cham province, Cambodia

Solar Green Energy (Cambodia) Co., Ltd (SOGE) was firstly founded in 2008 as Renewable Energy Development Association (REDA). The REDA's goal was to boost the use of green energy in Cambodia. In December 2013, the REDA registered as SOGE. SOGE's goal is to increase the investment in renewable energy sector, especially in solar energy. The company provides high quality and standard products and services, such as solar on and off grid, solar water pump, solar hybrid, and solar back–up system, solar streetlight, led light, solar sun tracker, mini–hydro power and min–grid.

The Solar Water Pump Project for irrigation implementing in Bateay District was invested by SOGE and supported by Netherlands Development Organization (SNV) with 20% of the project cost for a two–year period (2021–2023). This is part of SNV program to partner with the private sector to ensure the sustainable irrigation of smallholder farmers in Cambodia.

The beneficiaries of the MI–led project developed a case study on the Solar Water Pump Project with application of solar energy as a sustainable replacement of diesel fuel for crop irrigation in Cambodia. The objective was to (i) explore the current market situation of solar water pump implementing by SOGE with smallholder producers; and (ii) analyze the economic, social, and environmental impact created by the solar energy.

SOGE invested in 840 solar panels supported by the automatic sun tracking system with 335 watts for pumping water to the main pumping stations and 1,400 cubic meters/hour.

At the inception phase, 130 households of smallholders were selected to join Solar Water Pump project with a total of 600 hectares of rice fields (2–7 hectares per household). 80% of smallholders rented cultivation land with the annual rental of US$ 150–200 for farming. The participating smallholders can produce two crops (3 months for every crop), most in dry season to meet high demand from the Vietnamese market. In 2022, there were 144 smallholders participating in this project

Each smallholder signed 02 contracts with SOGE company for using irrigation water supported by the project: (i) the first contract with the service fee of US$112/ha/crop; and (ii) the second contract with the service fee of US$100 per/ha, i.e., US$12 discounted. The company planned to reduce the service fee with US$75/ha/crop by 2026. Accordingly, the company planned to increase its coverage of 1,000 hectares of rice fields in the next three years to take advantage of economy of scale.

The MI's project beneficiaries conducted the preliminary cost and benefit analysis for this case study. The analysis compared the results – it is more economical to use solar energy for water pump compared with use of diesel fuel as shown in Table 7. The calculation of costs and gross profit just focused on the irrigation costs by the two models, i.e., with an assumption that all other production costs are the same. The analysis also found that it would be more costly to use diesel fuel for irrigation water pumping in case the rice fields are located far from the main canal, e.g., 1000 meters, while solar water pump can save more cost.

TABLE 11-COST AND BENEFIT ANALYSIS

No	Items	Irrigation cost/ha	Sales	Profit
1	Private pumping station and sub–canals to rice fields	176	1,104	928
2	SOGE solar water pump (solar energy) and sub–canals to rice fields	156	1,104	948

The MI's project beneficiaries also found that the solar water pump technology can reduce the green gas emission (GHG) and create green jobs, especially for female farmers. However, some current challenges have still been existing:

- Diesel water pump is in use that results high production cost
- SOGE cannot install solar panels along sub–canals

Recommendation:

- SOGE consult with Commune Council and concerned agencies in charge of public irrigations on possibility to allocate land along sub–canals to install solar panels
- SOGE invest in mobile solar water pumps
- The government support through tax exemption imposed on solar energy-related facilities and equipment used for agricultural sector

Business Case 3: Handcrafted Cashew Nuts Stung Treng's Capacity Building for Cashew Farmers

Established in early 2021 in Siem–Bouk District, Stung Treng Province, Handcrafted Cashew Nuts Stung Treng's vision is to be part of the inclusive growth process and local community's prosperity. The company' semi–mechanized cashew nuts processing business has made a significant contribution through job creation and income generation to the local communities of cashew nut roasters (80% are women), local businesses, and etc. The company aims to provide high quality cashew nuts, including both semi–final products and final products coated with unique flavors to both retail and wholesale customers in domestic and overseas markets, such as East Asia, Europe, and North America.

Ms. Sothnita Soeun, Business Development Manager, attended the MI's capacity development program on Food Loss Reduction for Sustainable Value Chain in September 2022, and conducted her own localized training programs on (i) **CamGAP, Post–harvesting to reduce food loss and for sustainable value chain** (December 2022); and (ii) **Cashew Nuts Processing Technique** (February 2023) for **213** local people (most of them are farmers) in Cambodia. This action plan was implemented in collaboration with **GIZ** and **Cambodia Harvest** project funded by **USAID** that promotes sustainable, broad–based economic growth by increasing diversification and competitiveness and applying climate–smart agricultural technologies in the agriculture sector.

The core objectives of the two localized training programs were to**:**

- Strengthen the company's farmers' knowlege and awareness of Cambodian Good Agricultural Practices (**CamGAP)** and **food loss reduction** during postharvest and processing stages, especially for cashew nuts to ensure the good quality and high yield of cashew nuts to supply from the farm to customers, i.e. cashew supply chain
- Influence on the cashew nut farmers' adoption of **CamGAP** practices and further deployment

In compliance with the **ASEANGAP** introduced to ASEAN in 2006, the Ministry of Agriculture, Fishery and Forestry (MAFF) of Cambodia has established CamGAP in 2010. The government excecuted various projects to promote the adoption of the standard and supported small farmers to access high end markets, including (i) Agriculture Services Programme for Innovation, and Resilience and Extension (ASPIRE) and (ii) Accelerating Inclusive Markets for Smallholders (AIMS). They supported the production of safe vegetables in compliance with CamGAP and connect farmers to markets through contract farming model. Such development and research institutions as GIZ, HEKS, and New Zealand Plant and Food Research, have also been involved in promotion of safe vegetable production with adoption of CamGAP in Cambodia.

The participants of these localized training programs adopted best practices and benefits provided by CAMGAP and food loss reduction methods, including harvesting technique, cashew processing, cashew storage during and post harvesting periods, higher productivity, good quality cashew nuts, sustainable access to markets, higher income, etc. In addition to this action plan, the company recommended upcoming technical trainings on (i) cashew cultivation technique to combat climate change; (ii) smart cashew cultivation by irrigation system with use of solar panel energy in the near future to sustain good agricultural production practices and scale up the application of smart farming Stung Treng Province and Cambodia.

Business Case 4: Advantages and Challenges of Applying Smart Farming Technologies (IoTs) for Smallholder Mushroom Women Farmers in the Bago Region, Myanmar

Mr. San Min Tun, Freelance Agribusiness Researcher, the project beneficiary from the capacity development program on Sustainable and Smart Farming Technologies, implemented the action plans by holding the knowledge sharing sessions on IoT with mushroom farmer group (14) and several private agribusinesses in Bago region, Myanmar, in October 2022 and February 2023.

The localized trainings aimed to (i) cultivate and raise the awareness and knowledge of farmers and businesses on sustainable and smart farming technologies; and (iii) facilitate the improvement and sustainability of mushroom cultivation by understanding the benefit of smart technologies. This also examined both the advantages and challenges facing smallholder farmers, especially women, involved in mushroom production, in adopting IoT in the Bago region, Myanmar.

The Bago region is significantly potential for further mushroom cultivation development and application of smart farming technologies thanks to the presence of basic requirements and infrastructure, such as electricity, proper road and transportation, people's interest, and a market. Traditional mushroom cultivation practices produce low to moderate yield as compared with that supported by modern farming practices. The knowledge sharing with mushroom farmers was effective for smallholder women farmers who are genuinely interested in farming transformation.

Traditionally, mushroom farmers in Bago cultivate mushrooms in tightly enclosed wooden houses whose temperature and humidity were manually controlled and subject to guesswork. Maintaining the required environment for an extended period is challenging as it can negatively affect the quality and yield of mushroom. If the cultivation is supported by smart farming technologies, i.e., IoTs in the mushroom cultivation area, then these challenges could be overcome. Notably, the farmers interests in application of IoT exist but the lack of smart farming technologies, sources of supplies, supportive infrastructure, and high costs is a bigger concern where IoT technologies rely heavily on electricity and internet availability and access. Unfortunately, the targeted region like Bago and many rural areas lack adequate access to electricity and internet. Even if available, the government often cannot subsidize them, resulting in limited access for the farmers. Therefore, farmers need basic infrastructure equipped before their application and implementation of smart technologies.

Given the current diffiuculties and challenges, it is crucial to initiate support for potential farmers by raising funds, improving accessibility and availability of tools and technologies, while ensuring the basic infrastructure needs are met by the government and relevant parties. The project effectiveness lies in its ability to provide support and resources, such as funding, technical assistance, and technology sources, while local governments support basic infrastructure. An effective collaboration mechanism between stakeholders in the agricultural supply chain is important. The sustainability of application of smart farming technologies depends not only on individuals or farmers but also on an enabling environment and the other support from the government.

It is recommended that the project's support for harnessing the power of IoT–based technologies continue because it helps smallholder farmers, especially women enhance their productivity, improve their livelihoods, and contribute to the sustainable development of the agricultural sector in the region.

CHAPTER V. POLICY BRIEF ON ADVANCING AGRICULTURAL DIGITALIZATION IN THE MEKONG COUNTRIES

At the global level, the negative impact of the COVID–19 pandemic has caused economic recession. The governments' containment policies have accelerated the digitalization process, making structural change toward a more digital economy. Digital transformation through digital connectivity, digital technology applications and digital data is an effective solution for economic recovery and sustainable development in response to the impact of the COVID–19 pandemic.[18]

The policy brief focuses on the agricultural digitalization in the Mekong countries where agriculture sector and agricultural supply chain play dominant role in economic development toward sustainability. This policy brief highlights several enabling factors in response to the existing problems on agricultural digitalization and **implications for strengthening of the smallholder Agri-Tech investing ecosystem** in support of the sustainable development of agriculture, energy, and logistics and transport sectors. Specifically, this **policy brief concentrates in accelerating the digital transformation process in agriculture sector in the Mekong region**.
In ASEAN, there are various digital initiatives related to food and agriculture sector as follows:[19][20][21]

- ASEAN Digital Master Plan 2025 has provided guidance to the ASEAN member states (AMSs) through five–actions to achieve both digital economy and digital society. Digital technologies, services and ecosystem powering ASEAN are used to address agricultural issues interlinked with climate change.
- Consolidated Strategy on the Fourth Industrial Revolution for ASEAN, October 26, 2021 by ASEAN Leaders providing guidance for AMSs within building the ASEAN Digital Community in the field of political and security, economy, and socio-culture where Food and agriculture sector is included in form of smart agriculture adoption.
- ASEAN Comprehensive Recovery Framework (ACRF) and its Implementation Plan, 12 November 2021 by ASEAN Leaders served as a consolidated exist strategy and comprehensive recovery efforts from the pandemic, which consists of five broad strategies.
- ASEAN Guidelines on Promoting the Utilization of Digital Technologies for ASEAN Food and Agricultural Sector, 27 October 2021 by ASEAN Agriculture and Forestry Ministries cover five key guidelines for AMSs and various stakeholders in the field of food and agriculture sector in making data–driven decisions for digital technologies choices, utilization, and assessment to achieve 4.0.

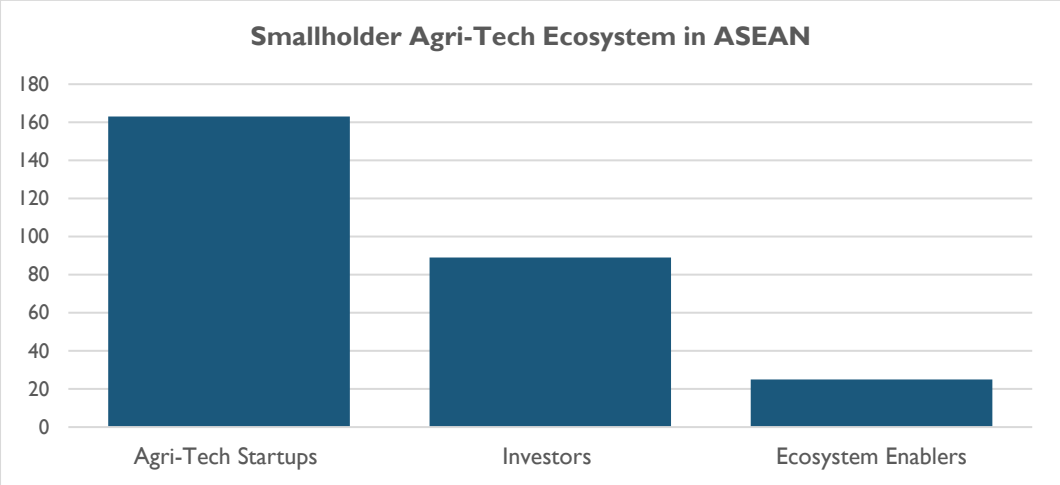
Similarly, digitalization is central to the efforts of the Greater Mekong Subregion (GMS) governments to build a robust economy in 2030. Agriculture sector is one of the priorities in the GSM 2030 agenda that encourages all members to promote inclusive digitalization and the use of advanced technologies in all GMS Program.[22]

The agricultural digitalization under the regional and subregional frameworks is relevant to each of state members. The mentioned agriculture–related frameworks, strategies, and guidelines could be a milestone for all countries to collaborate each other in the embodiment of digital agriculture including investments, joint cooperative projects, digitalized entrepreneurship, and introduction and application of innovative digital technologies. The advancement of these digital initiatives in the agriculture sector will significantly contribute to national economic recovery progress during and post pandemic period. [23]

[18] International Monetary Fund (IMF), 2023, Digitalization during the COVID-19 Crisis
[19] https://asean.org/book/asean-digital-masterplan-2025/
[20] https://asean.org/consolidated-strategy-on-the-fourth-industrial-revolution-for-asean/
[21] https://asean.org/wp-content/uploads/2021/12/FAFD-52.-ASEAN-Guidelines-on-Promoting-the-Utilization-of-Digital-Technologie.pdf
[22] https://www.greatermekong.org/g/sites/default/files/GMS-Building-Digitally-Connected-1-December-2022-single-pages-QRCODE-smallfilesize.pdf
[23] https://www.ide.go.jp/library/English/Publish/Reports/Brc/pdf/27_06.pdf

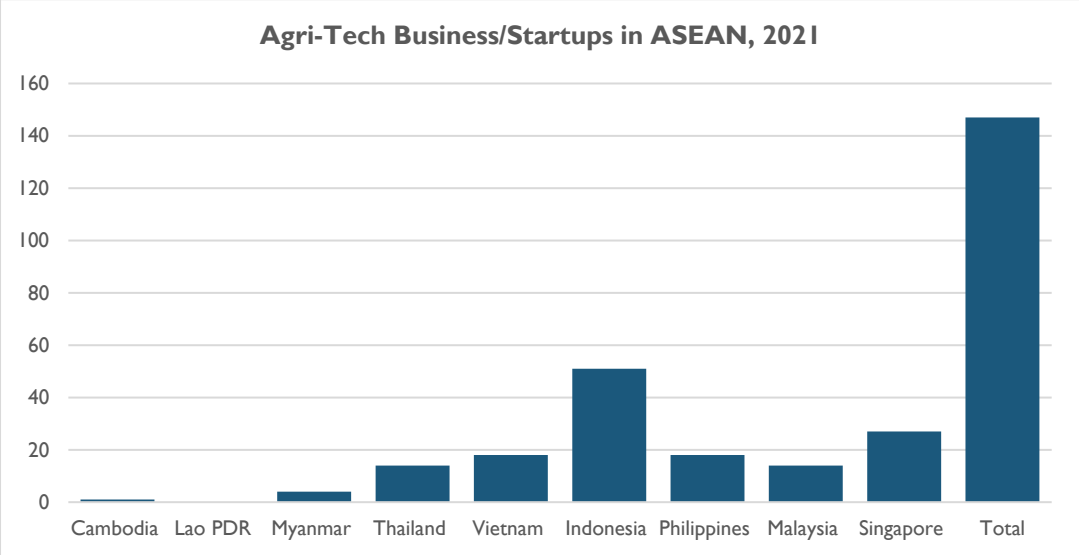
The smallholder Agri–Tech ecosystem in support of agricultural digitalization in ASEAN covering the Mekong countries include (i) Agri–Tech businesses/starups, (ii) Investors, and (iii) Ecosystem Enablers, such as governments, donors, research, and development (R&D) institutions, accelerators, innovators, NGOs, etc., is still small but growing (Figure 8). The number of Agri–Tech businesses/startups in the Mekong countries is smaller than those in the Philippines (18), Singapore (27), and Indonesia (51) in 2021, respectively, as shown in Figure 9.

FIGURE 8-SMALLHOLDER AGRI-TECH ECOSYSTEM IN ASEAN



Source: GrowAsia, 2021, Smallholder AgriTech Southeast Asia Landscape

FIGURE 9-AGRI-TECH BUSINESS/STARTUPS IN ASEAN, 2021



Source: GrowAsia, 2021, Smallholder AgriTech Southeast Asia Landscape

In the ecosystem, Agribusinesses enterprises play an active role in working smallholder farmers as goods and services providers or farm produce off–takers. Agribusinesses may choose to develop in–house digital solutions to create a longer–term competitive advantage while other companies may choose an open approach to collaborate innovators/startups. It can be seen that early–stage Agri–Tech startups need investment to grow, but a new technology may not be delivered to farmers or agribusiness based on revenue target alone. In fact, smallholder technologies rarely meet the requirements of capital funding. From the investment side, the number of impact investors increases, showing interests in the food and agriculture sector. With that being said, impact investing has encountered difficulties as the value chain smallholder farmer production is assessed as one of the most fragmented and difficult to measure impact

due to smallholders' diversity and lack of baseline data. As the main policy enabler, the governments in the Mekong countries have enabled their business environment to engage with the private sector and promote smart technologies. However, national digital agriculture strategies, programs, and actions have certain limitations to date.

The common technologies as well as challenges facing the digital transformation are mentioned in Chapter 3 of this report and the status of smart agriculture development was reflected in this project's study report.[24] While a holistic approach and comprehensive solutions are needed, the Policy Brief proposes an improvement in several existing innovative models (Table 12) as an integral part of the Agri–Tech ecosystem to respond to the on–going challenges and further empower smallholders and sustainable and inclusive development of agriculture sector to the Mekong countries for consideration at least in the short–term and medium–term and especially for those where the agricultural digitalization progress is still behind the others in the same region/subregion.

TABLE 12-PROPOSED INNOVATIVE MODELS

Proposed Innovative Model	Technical Solutions
Hardware Development	A cluster of new devices: (i) drones and robots which automate on–farm tasks including spraying, weeding, and harvesting; (ii) IoT sensors to help farmers monitor their farms and inform effective decision making; and (iii) critical machines like harvesters and combines which are affordable, and open up opportunities for digitally enabled rental services.
Digital Farmer Advisory Services	Digital advisory applications provide advice and information to farmers. Typical solutions will be provided over a social media platform and seek to migrate farmers over to an Android mobile application, where farmers create profiles, and receive more customized advice. This helps solve the problems where smallholder yields in the Mekong countries are well short of both international benchmarks and yields on larger farms in the region, and lack knowledge and information, including on seed selection, pest identification, climatic conditions, and planting timing.
Digital Trading Platforms	These technologies meet increasing demands for use of digital tools in trading, managing inventory and trucking routes, and communicating with farmers through databases and apps.
Capacity Development	Technical assistance projects/programs factoring thematic capacity development programs to build capacity for the investing impact ecosystem, including farmers and impact MSMEs, investors, and ecosystem enablers, such as the concerned government ministries and agencies, research institutions and universities, NGOs, etc., on impacting businesses, investments, and technologies. These will increase access to smart and sustainable technologies and sustain the agricultural digitalization process.

To mainstream the proposed innovative models, it is recommended that the governments of the Mekong countries prioritize the following:

- Further strengthen the legislation on digital economy for agriculture sector with priorities for digital technologies for agricultural transformation
- Further enable business and investment environment to attract more private capital from both domestic and foreign impact investors into Agri–Tech businesses/startups
- Further promote public–private partnership (PPP) modality to engage with the private sector stakeholders, e.g., businesses, innovators, business incubators, accelerators, etc. to accelerate agricultural digitalization process
- Mobilize fundings and technical assistance from international donors (multilateral and bilateral) and international development organizations and individuals to implement both infrastructure

[24] Mekong Institute, 2022, Study Report on Smart Technologies in the Agriculture Sectors in Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam

investment and capacity development programs / projects to enhance capacity for the organizations and people in the Agri–Tech ecosystem as well as harnessing smart and sustainable technologies in the agriculture sector.

CHAPTER VI. ISSUES, LESSONS, AND FOLLOW–UP ACTIONS

A. Issues

The project has identified and addressed significant issues through country situation assessments, and introduced and promoted smart technologies in agriculture, energy, and logistics and transport sectors in the Mekong countries through its capacity development programs. This evaluation noted that the agricultural digitalization in the Mekong countries and the project per se remains beset with a number of challenges given the complexity of the agriculture, energy, and logistics and transport sectors.

- Although the capacity of the project's direct and indirect beneficiaries may have been improved with the assistance of the project, the adoption and application of smart technologies are limited. This explains that additional intervention, e.g., technical assistance and investment, beyond this project timeframe is needed.
- Project's training curricular should have been more technically intensive.
- The project was implemented and managed by various departments and units in Mekong Institute (MI), but it lacked an effective monitoring and evaluation (M&E) framework. This weakness may affect the project results in terms of monitoring and measuring the project's long–term outcomes and projecting its sustainability and impact.

B. Lessons

The project has seen several leasson learnt from the its implementation period as recorded by the evaluation.

- An adequate project management structure, including M&E framework, targets, and indicators should be established at the project design stage and fully impemlented during the project cycle.
- A more effective coordination among MI's departments to get the project benefciaries involved in more than one capacity development program could widen the project results.
- Risks that may undermine project implementation, such as resource limitation and beneficiaries' readiness and capability to adopt, invest, apply, and deploy smart technologies in the three sectors, durinng and in post project completion period should be identified at the project design and mitigated during the project implementation.
- Capacity development programs need further improvements in terms of applied business models and best practices in line with business context of the Mekong countries to attract more private sector participants who can realize and apply the project results to their business activities

C. Follow-Up Actions

The project evaluation has proposed the follow–up actions as below:

- Mekong Institute (MI) consider the next phase(s) of this project with an in–depth intervention through intensive capacity development programs and/or technical assistance to the beneficiaries in support of digital transformation in agriculture, energy, and logistics and transport sectors.
- The Mekong countries consider the recommendations under the Policy Brief as well as those suggested by the Country Situation Assessments to accelerate the agricultual digitalization process in the Mekong countries with successes.

ANNEXES. PROJECT EVALUATION AND RATING

Annex 1. Evaluation Framework

TABLE 13-EVALUATION FRAMEWORK

Evaluation criteria by OECD-DAC	Evaluation questions [25]	Judgement criteria / indicators	Means and sources of verification / Data collection method
1. Relevance The extent to which the intervention objectives and design respond to beneficiaries, global, country, and partner/institution needs, policies, and priorities, and continue to do so if circumstances change.	**EQ 1**. To what extent did the Project meet the needs of the target beneficiaries (direct and indirect) from agriculture, energy (renewable energy), and transport and logistics sectors in terms of institutional, organizational, and individual skills and competency?	• The project design and support is perceived as relevant to the needs of the project beneficiaries and/or stakeholders given the Mekong development context • The size and regularity of the project support is perceived as adequate to meet the project beneficiaries • Project inclusion (gender sensitization, training needs, sectors, category of organizations, etc. is integrated in the project design).	**Secondary data** • Approved project proposal/project design, and project studies/reports, progress reports • Project M&E reports • Other related documents **Primary data** • Online survey with all training participants from the Mekong countries • Semi–structured KIIs with (i) MI's representatives from ADC, SEE, TIF, and MEL departments, (ii) Project Advisory Committee (PAC) members, and Technical Working Group (TWG) members • FGDs with core representatives of the training participants from the Mekong countries
2. Coherence			**Secondary data**

[25] Key coding for the evaluation questions:

First digit	Second digit
1 = EQ1 (RELEVANCE)	.1 = first question for the particular EQ
2 = EQ2 (COHERENCE)	
3 = EQ3 (EFFECTIVENESS)	
4 = EQ4 (EFFICIENCY)	
5 = EQ5 (SUSTAINABILITY)	
6 = EQ6 (IMPACT)	

Evaluation criteria by OECD-DAC	Evaluation questions [25]	Judgement criteria / indicators	Means and sources of verification / Data collection method
The compatibility of the intervention with other interventions in a country, sector, or institution.	**EQ 2**. Was the Project in consistency and complementarity with the Mekong countries' policies and/or initiatives on promoting sustainable agricultural development to reduce post–harvest losses, increase energy efficiency, and adopt cold chain development and smart logistic technologies?	• The project intervention aligned with and supplemented the Mekong governments' sustainable agricultural development policies and/or initiatives , the project beneficiaries' organizations (public and private types) • The project intervention aligned with other projects and other interventions carried out by MI	• Approved project proposal/project design, and project studies/reports, progress reports • Project M&E reports • Other related documents **Primary data** • Online survey with all training participants from the Mekong countries • Semi–structured KIIs with (i) MI's representatives from ADC, SEE, TIF, and MEL departments, (ii) Project Advisory Committee (PAC) members, and Technical Working Group (TWG) members • FGDs with core representatives of the training participants from the Mekong countries
3. Effectiveness The extent to which the intervention achieved, or is expected to achieve, its objectives, and its results, including any differential results across groups.	**EQ 3**. What changes have occurred and to what extent have the project intervention contributed to the project beneficiaries?	• The achievements of the project objectives, long–term and intermediary outcomes/results • The quality of the project implementation approaches and strategies, project management, and M&E processes: (i) actual activities and results compared with project planning; (ii) monitoring and evaluation (M&E) framework; (iii) successes, challenges, and lesson learnt; and (iv) Stakeholders and beneficiaries' participation	**Secondary data** • Approved project proposal/project design, and project studies/reports, progress reports • Project M&E reports • Other related documents **Primary data** • Online survey with all training participants from the Mekong countries • Semi–structured KIIs with (i) MI's representatives from ADC, SEE, TIF, and MEL departments, (ii) Project Advisory Committee (PAC) members, and Technical Working Group (TWG) members • FGDs with core representatives of the training participants from the Mekong countries
4. Efficiency		• Value for money–cost efficiency and timeliness in project delivery	**Secondary data**

Evaluation criteria by OECD-DAC	Evaluation questions [25]	Judgement criteria / indicators	Means and sources of verification / Data collection method
The extent to which the intervention delivers, or is likely to deliver, results in an economic and timely way.	**EQ 4**. Were the project resources mobilized and used to achieve the project results in an efficient manner?		• Approved project proposal/project design, and project studies/reports, progress reports • Project M&E reports • Other related documents **Primary data** • Online survey with all training participants from the Mekong countries • Semi–structured KIIs with (i) MI's representatives from ADC, SEE, TIF, and MEL departments, (ii) Project Advisory Committee (PAC) members, and Technical Working Group (TWG) members • FGDs with core representatives of the training participants from the Mekong countries
5. Sustainability The extent to which the net benefits of the intervention continue or are likely to continue.	**EQ 5**. What outcomes/changes will be sustained as the project's long–term outcomes?	• The degree to which the project outcomes is perceived as sustainable by different stakeholders • Level of capacity and preparation by the project beneficiaries and stakeholders towards sustainability	**Primary data** • Online survey with all training participants from the Mekong countries • Semi–structured KIIs with (i) MI's representatives from ADC, SEE, TIF, and MEL departments, (ii) Project Advisory Committee (PAC) members, and Technical Working Group (TWG) members • FGDs with core representatives of the training participants from the Mekong countries
6. Impact The extent to which the intervention has generated or is expected to generate significant positive or negative, intended, or unintended, higher–level effects.	**EQ 6**. What is the likely impact created by the project?	• The likely impact on the project beneficiaries' knowledge and practices for contributing to agricultural productivity and quality and economic competitiveness led by green and smart agricultural supply chains in the Mekong countries	**Primary data** • Online survey with all training participants from the Mekong countries • Semi–structured KIIs with (i) MI's representatives from ADC, SEE, TIF, and MEL departments, (ii) Project Advisory Committee (PAC) members, and Technical Working Group (TWG) members

Evaluation criteria by OECD-DAC	Evaluation questions [25]	Judgement criteria / indicators	Means and sources of verification / Data collection method
			• FGDs with core representatives of the training participants from the Mekong countries

Annex 2. Evaluation Rating

TABLE 14-EVALUATION RATING

Rating Value	Relevance	Coherence	Effectiveness	Efficiency	Sustainability	Impact
3	Highly relevant	Highly coherent	Highly effective	Highly efficient	Most likely	Most likely
2	Relevant	Coherence	Effective	Efficient	Likely	Likely
1	Partly relevant	Partly coherent	Partly effective	Partly efficient	Less than likely	Less than likely
0	Irrelevant	Incoherent	Ineffective	Inefficient	Unlikely	Unlikely

Greater Mekong Subregion

The Greater Mekong Sub-Region (GMS) comprises of five Southeast Asian countries and two provinces of China sharing the Mekong River, namely Cambodia, Lao PDR, Myanmar, Thailand, Vietnam and Yunnan Province, Guangxi Autonomous Region of the People's Republic of China.

About Mekong Institute

Mekong Institute (MI) is a **GMS** Inter-Governmental Organization (IGO) working closely with the Governments of six countries to promote regional development, cooperation and integration by offering standard and on-demand capability development programs across three cutting themes of agricultural development and commercialization, trade and investment facilitation, and sustainable energy and environment.

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