Thailand

Executive summary of Report of Data Collection Survey on the Promoting Smart Agriculture in Thailand

Final report

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Japan International Cooperation Agency (JICA)

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Part 1 – Background and future directions for promoting smart agriculture in Thailand

A. Background and purpose of the survey

Agriculture, one of Thailand's primary industries, is shrinking and faces challenges such as low productivity, environmental pollution, and a lack of labor force. The government has approved a strategy to promote the BCG economic model and smart agriculture as a national strategy. However, the adoption of smart farming technologies is limited due to the high age of farmers, low IT literacy, and lack of funding. To improve agricultural productivity, younger and new farmers should be attracted, and smart farming technologies should be introduced. **This survey will explore Thailand's agricultural issues, government and private sector efforts, potential smart agriculture technologies, and possible solutions through co-creation between Japan and Thailand.**

B. Why agriculture is a key strategy to pursue Thailand's sustainable growth

1. Thailand has the advantage on biodiversity

Thailand is one of the most biodiversity-rich countries in Southeast Asia. With its location near the equator and with its numerous rivers and streams, Thailand has a more fertile environment, including soil, water, minerals, and the amount of sunlight throughout the year, which is appropriate for the habitation of living organisms.

2. Global food demand is likely to grow significantly, thus Thailand should grab the opportunity in agri-food sector

According to the World Economic Forum, the food industry has an average growth of 13.8% globally. Therefore, the Government of Thailand is trying to capture the opportunity by diversifying kinds of agricultural crops and products, improving the food production process by implementing technologies, and stabilizing the sector. In addition, the government is expecting Thailand to become the bio-hub and the world's leader in food production and trade[1].

3. Thailand has high employment in the agricultural sector, thus the promotion of this sector would have a great impact for over one-third of the population.

Although agriculture accounts for less than 10% of the country's GDP, the sector employs more than one-third of the country's labor. Therefore, prioritizing the sector's improvement will impact the whole country positively and will lower the gap of inequality in Thailand. By having new agricultural technology and further supports, standard of living for more than 30% of Thai population will be improved impactfully[2].

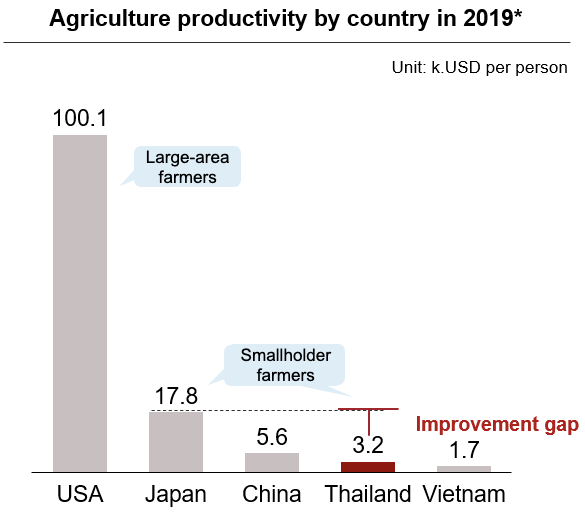
[1] Global Compact Network Thailand, 2022
[2] The International Trade Administration, 2022

C. Why Thai agriculture should move towards the smart agriculture

Thailand's government aims to **transform traditional agriculture into smart agriculture** to improve international competitiveness and become a world leader in agriculture. Three main hurdles are hindering this goal: **1) low productivity, 2) low added value, and 3) labor issues** such as high costs and a declining agricultural labor force.

1. Low productivity

Thailand's agricultural productivity has potential to grow but has a ceiling in the long run. The sector's GDP proportion is low while employing over 30% of the population, indicating low productivity. To raise competitiveness, smart technologies such as AI should be adopted to increase crop yield[3].



2. Low added value

The low proportion of processed agricultural crops suggests that they do not generate high value for the economy. Most exported crops are in the form of raw or primary processed products, which have lower value. Insufficient technological advancements in Thailand hinder the ability to add significant value to agricultural crops. Innovative R&D, machines, branding, marketing, and commerce tools are needed to increase the competitiveness of Thai agricultural outputs in the global market.

3. High labor costs and declining agri-population

Thai agricultural sector faces high labor costs compared to neighboring countries, which hinders price competitiveness. Smart agriculture could lower production costs in the long run. Additionally, the declining agricultural labor force is a concern, as more people shift to other sectors. Automation and other technologies could help fill this gap, as demonstrated by Japan's use of robotics in agriculture.

[3] World bank, 2019

Part 2 – Current agricultural issues and solutions provided by public and private sectors

A. Top agricultural issues in Thailand

Thai agriculture is losing competitiveness globally due to high production costs and low crop productivity. Input costs, such as labor, land, and agricultural chemicals, have increased significantly, and the proportion of the agricultural sector's GDP is low. Despite employing over 30% of Thailand's population[4], around half of all Thai farmers live below the poverty line[5], with low income and growing debts[6]. The main issues are high costs and low revenue, with 16 root causes identified in the table below.

Table 1: Root causes of the main issues of Thai farmers

Key factors	Sub-issues	Root Causes
High Cost	High production cost	1. Farmers have **high land renting price**
		2. Farmers pay **high utility (electricity, water)** price
		3. Farmers pay **high interest rate** borrowing from loan shark
		4. Farmers pay **high labour cost**
		5. Farmers pay **high cost for agricultural inputs** such as fertilizers, pesticides
		6. Agricultural input usages **are not optimal**
		7. Farmers have **limited knowledge and tools for financial management**
	High risk low hedge	8. Crops are affected by **uncontrolled external factors** (i.e. flood, diseases)
Low Revenue	Low crop quantity	9. The land is not fully **utilised for planting**
		10. Crops are **not suitable to the planting area**
		11. Crops can be **harvested only in some seasons**
		12. **Crops get spoiled** before reaching end customers
	Low crop price	13. Crops are sold at **low price** e.g. controlled by middlemen
		14. Farmers keep planting **low demand crops resulting in oversupplies**
		15. Crops have **low quality**
		16. Farmers do **not implement branding and marketing activities**

According to agricultural education expert interviews, the high-priority agricultural issues are shown in Table 2 below. The approach to prioritize issues is to weigh the priority of each issue by the impact level on Thai agriculture market value affected and the population scale of farmers who are affected by each agricultural issue.

[4] United Nations, 2020
[5] Office of Agricultural Economics, 2019
[6] Survey of farmer's financial behavior from 2019–2020, calculated by team researchers, 2020

Table 2: The summary of high-priority agricultural issues[7]

Rank	Agricultural issues
1	Farmers pay **high cost for agricultural inputs** such as fertilizers, pesticides
2	Agricultural input usages **are not optimal**
3	Farmers have **limited knowledge and tools for financial management**
4	Crops are affected by **uncontrolled external factors** (e.g. flood, diseases)
5	Crops are sold at **low price (**e.g. controlled by middlemen)
6	Crops are sold at **low price (**e.g. oversupply)
7	Crops have **low quality**

Moreover, according to on-site farmers survey[8], most farmers pointed out that their high-priority agricultural issues are **1) Farmers pay high cost for agricultural inputs such as fertilizers, pesticides**, **2) Crops are affected by uncontrolled external factors (e.g. flood, diseases)** and **3) Crops are sold at low price because the price is controlled by middlemen.**

Table 3: Percentage of farmers facing each high-priority issue

Agricultural issues	% of farmer's answers
A [High cost] Farmers pay high cost for agricultural inputs such as fertilizers, pesticides	**90%**
B [High cost] Agricultural input usages are not optimal	20%
C [High cost] Farmers have limited knowledge and tools for financial management	11%
D [High risk] Crops are affected by uncontrolled external factors e.g. flood, drought, pestilence	70%
E [Low selling price] Crops are sold at low price e.g. controlled by middlemen	56%
F [Low selling price] Crops are sold at low price e.g. oversupply	25%
G [Low selling price] Crops have low quality	16%
Other issues	12%

***** Other issues in this survey refer to insect infestation, lack of agricultural tools, lack of labors, lack of knowledge of doing online sales.

[7] See Appendix 1 (Agri experts' interviews)
[8] See farmer survey and KOL farmer survey supplementary report

B. Solutions and movements from Government of Thailand

Thailand is focusing on improving the agricultural sector

Thailand's Twenty-Year Agriculture and Cooperative Strategy (2017-2036) prioritizes the agricultural sector for sustainable development, and aims to empower farmers with technology and appropriate practices. Budget is allocated to distribute Agtech devices, train farmers, and fund R&D processes. The BCG model is implemented to improve citizens' standard of living and distribute economic opportunities across the country, with a focus on the strategic sectors of agriculture and food, wellness and medicine, energy, materials and biochemicals, and tourism and creative economy.

In Table 4, we listed up the examples of current solutions and movement from Government of Thailand to solve 16 agricultural issues.

Table 4: Summary of Thai agricultural issues and current government's actions

Issues			Government Actions
High cost	High production cost	High land renting price	Platform for land renting
			Thanaruk Pracharat project (low-rate state owned land renting)
			Land leasing fee control
		High utilities price	Quotas for free water
			Free electricity for agricultural purpose
		High interest rate borrowing from loan shark	Credit support to buy back and create added value on rice
			Green Credit project (low-rate loan for farmers who integrate BCG model)
			Special interest rate loan for farmers
			Digital Factoring (more access to capital)
		High labour cost	Laws to protect informal workers
			Smart Farmers (technologies for long-term efficiency utilization)
			Agricultural machinery promotion
		High cost for agri- inputs	Proper fertilization knowledge transfer
			Organic fertilizer usage encouragement
			Marketing organization for farmers (suppliers connect to farmers directly without middleman)
			Agricultural chemical discount program
			Selling innovative bio fertilizer at low price
			Agricultural bank
		Agri-input usages are not optimal	Soil quality improvement
			LDD program: (suitable planting area analysis)
		Limited knowledge and tools for financial management	Accounting training project
			Digital Factoring (financial skills transfer)
			Smart Me application (accounting tool)
			Cooperative and Farmer Financial Information Service System (Web Service)
			OAE RCMO application (production cost calculation tool)
	High risk, low hedge	Crops are affected by uncontrolled external factors (eg. floods, diseases)	Debt support policies for flood victims from BAAC
			Payment of principal suspension for flood victims
			Compensation for flood victims in 65 provinces
			Royal project for developing water resource (weir and canal construction to ease out floods)
			Large Agricultural Extension System Project

Issues			Government Actions
Low sales revenue	Low crops quantity	Land is not fully utilised for planting	New theory agriculture support (land and water division into clear proportion)
			Agri-Map Website (information for proactive management)
		Crops are not suitable to the planting area	Zoning by Agri-map and Farmbook application (tool for zoning)
			LDD Zoning Web application (information about 13 economic crops)
			www.thaismartfarmer.net database system (guidelines for Smart Farmer)
		Crops can be harvested only in some seasons	Special employment for water resource development
			Agricultural productivity incremental policy
			"One Province One Project One Program" project (upskill and reskill workers)
			Supplementary career program
		Crops get spoiled before reaching end customers	Cold chain system development
			Developmental plan for logistics systems in the agricultural sector
			A-Farm Mart platform (Cost optimization)
	Low crops price	Crops are sold at low price	Selling price guarantee for economic crops
			OAE.-Ag-Info application (information about daily agricultural product's price)
			Agricultural market system
		Planting low demand crops resulting in oversupplies	Loan for slow-down in-season rice selling project
			Income guarantee from rice planting farmer project
			Rice quality and management support project (financial support)
			Smart Products (knowledge in product processing)
		Low quality crops	Policy to encourage products to be certified with quality standards
			Farming 4.0 (technology utilization to optimize productivity and increase quality of goods)
			Organic Farming Promotion
			BCG Model (value-based and innovation-driven economy transformation)
		Lack of branding & marketing activities	Branding support to match with niche market needs
			OTOP policies (unique locally made products)
			Supports for added-value technology and innovation
			Promotion of the development of creativity and innovation (identity development)

Government of Thailand is implementing policies and projects to solve 16 agricultural issues, targeting country-wide farmers. These solutions are aligned with the 20-Year National Strategy and grouped into four categories as follows:

1. **Financial supports** such as subsidies, discounts, and giveaways
   - They are mainly used as **short-term support** towards urgent situation such as flood, drought, and agricultural crop's price volatility.
   - The main objective is to provide monetary supports to help farmers with **financial issues.** E.g. Agricultural chemical discount program and compensation for flood victims.
2. **Marketing and sales channel supports** such as platforms and marketplace.
   - The main objective is to connect buyers and sellers directly, resulting in transparent price optimization. E.g. Marketing organization for farmers and MOC Agri Mart Application
3. **AgTechnology and innovative systems** such as machine utilization
   - The main objective is **to improve efficiency and productivity in the long run.**
   - Recent activities aim to increase the number of **smart farmers** by enhancing more technology and innovations in agricultural production processes. E.g. Farming 4.0 and the Chemical fertilizer management plan

- Some activities also promote green products and processes which align with the Eco-Friendly Development and Growth section under the 20-Year National Strategy. E.g. The BCG model and Organic Farming
- Some activities are still in the progress of research and development. E.g. Cold chain system development

4. Agri-Education[9]

- The main objective is to provide significant know-hows and skills that can be applied to farmers' businesses to solve the financial and operational issues and improve overall agricultural processes including farming technologies, farm management, and marketing and branding of agricultural outputs.
- Most are provided in the form of **trainings and applications/websites,** aligned with the Human Capital Development and Strengthening section of the 20-Year National Strategy. E.g. Cooperative and Farmer Financial Information Service System, Agri-Map Website, and OTOP trainings

While all solutions listed above will be considered in the analysis, solutions that are not aligned with the 20-Year National Strategy will not be evaluated in this project i.e., the laws to protect informal workers. Nevertheless, there are still on-going issues that have not been completely solved, implying that **these policies are ineffective and do not create significant improvement in terms of their impact levels on the current agricultural problems**, which will be discussed in the next part of the report.

[9] See Appendix 4 (Table 4-3 and Table 4-4)

To enhance above solutions and movements to promote the smart agriculture in Thailand, there are many ministries and government departments getting involved in the agriculture improvement activities. Here, we summarized the main organization that has direct responsibilities to drive agricultural improvement and the indirect collaborators in the table 5.

Table 5: The summary of government organization related to agriculture in Thailand

Topic	Government Department	Government's action
Agricultural related budget	Ministry of Agriculture and Cooperatives, Ministry of Commerce and Bank for Agriculture and Agricultural Cooperatives	Provide the **subsidies for price guarantee project** in having fixed price for industrial crops
	Budget Bureau	**Allocate national budget** to all ministries
Agricultural database	National Science and Technology Development Agency	Take care of **government's database and consolidate data** from different departments
Agtech development	National Innovation Agency, Ministry of Higher Education, Science, Research and Innovation	Pushing **Agtech R&D development** for startups and foster **Agtech ecosystem by connecting them with third parties**
	National Science and Technology Development Agency, Ministry of Science and Technology	1) Provide **funding to researchers** and private solution providers 2) Offer **incentives and benefits for state researchers**
	Department of Agriculture	Create the **state-owned agricultural related applications** and Agtech for farmers
	The revenue department, Ministry of Finance	Provide **tax exemption** for startup individuals and companies due to the government policy in increasing Thailand's competitiveness
	Office of Agricultural Economics, Ministry of Agriculture and Cooperatives	Set up **agricultural demonstration plots** as the Agtech project trial for farmers
	Mae Fah Luang Foundation	**Propose agricultural projects** in both developing farming productivity and educating farmers to have high yield
	Ministry of Higher Education, Science, Research and Innovation	Create **research sandbox** to imitate the utilization in real environment
	Digital Economy Promotion Agency, Ministry of Digital Economy and Society	Provide **digital manpower fund** in developing individuals or startup companies to coping technologies in agricultural sector
	Department of skilled development, Ministry of Labor	Set up **smart plants nation wide for upskilled farmers** to become smart farmers
	Department of foreign trade, Ministry of Commerce	**Export and import and tax tariff** of Agtech in Thailand

Topic	Government Department	Government's action
Agtech penetration	The National Broadcasting and Telecommunication Commission, Ministry of Digital Economy and Society	**Import and register drones** for agriculture
	Department of Agriculture Extension and Agricultural Extension Office, Ministry of Agriculture and Cooperatives	Allocate **local budget in distributing the Agtech** devices and tools in their area
	Ministry of Agriculture and Cooperatives 1) Department of Agriculture 2) Provincial Administrative Organization	Set up **Agtech and agricultural related trainings** for farmers to increase yield, lower production cost, and connect to technologies
Agtech promotion	Provincial Administrative Organization, Ministry of Interior	**Carry down the Agtech trainings** to farmers themselves
	Ministry of Agriculture and Cooperatives and Federation of Thai Industries	Develop the **Agtech precision farming projects to increase quality and yield** of the agricultural crops and **connect growers to factories**
Agricultural products branding and marketing	Community Development Department, Ministry of Interior	**Promote and uplift OTOP products through branding** and connect OTOP to e-commerce platform (Shopee)
	Ministry of Agriculture and Cooperatives	Carry down **value added projects to uplift the agricultural crops** by increasing standard with qualified trademark
Agricultural products selling	Rice Exporters Association of Thailand, Ministry of Commerce	**Export Thai rice** to oversea countries
	Ministry of Commerce	Connect internal market with **oversea markets for seeking agricultural crops** in responding to the demand
	Department of Internal trade, Ministry of Commerce	**Control and resolve pricing issues** regarding to the agricultural crops internal trading
	Office of Agricultural Economics, Ministry of Agriculture and Cooperatives	**Manage agricultural crops exports** to oversea countries
	Marketing Organization for farmers, Ministry of Agriculture and Cooperatives	Create **marketing organization for farmers where it connects suppliers to farmers** directly without middleman

Topic	Government Department (indirect players)	Agricultural improvements activities
Collaboration with agricultural improvements	The treasury department, Ministry of Finance	**Propose low-rate state owned land renting**
	Ministry of Interior	**Land leasing fee control** to make the fair price standard
	The Land Bank Administration Institute, Ministry of Interior	Provide **platform for direct land renting** between tenants and lenders without agency
	Office of The National Water Resources, Prime Minister's Office	Provide **quotas for free agricultural water** for farmers who own land less than 63 rai
	Provincial Electricity Authority and Department of Local Administration	Provide **free electricity** for agricultural purpose
	Bank for Agriculture and Agricultural Cooperatives	Manage Green Credit project which provides **low-rate loan for farmers who integrate BCG model** in their farming
	Ministry of Labour	Propose **laws to protect informal workers** in agricultural sector
	Ministry of Agriculture and Cooperatives	Provide information for farm management to **manage balance of resources and agricultural inputs** (Agri-Map website)
	Department of Agriculture Extension and Cooperative Promotion Department	Transfer **knowledge and technology in using proper amount of fertilizer**
	Agricultural Chemistry Group, Agricultural Production Science Research And Development Office	Sell **innovative bio fertilizer at low price** to farmers
	Bank for Agriculture and Agricultural Cooperatives	Manage **agricultural bank** for lending, exchange, withdraw, deposit agricultural products including inputs
	Cooperative Auditing Department, Ministry of Agriculture and Cooperatives	Implement **web service accounting tool** for cashflow management
	Ministry of Agriculture and Cooperatives	Provide s**ubsidies for flood victims** in farming area
	Royal Irrigation Department, Ministry of Agriculture and Cooperatives	Carry down **Royal project for developing water resource** for building weir and canal construction to ease out floods
	Ministry of Agriculture and Cooperatives	Enhance **agricultural productivity incremental policy** in crops rotation in seasons
	Office of Agricultural Economics, Ministry of Agriculture and Cooperatives	Develop **cold chain system** with supported universities in the EEC area
		Set up logistic and warehouse hub as **agricultural distribution center** to distribute agricultural crops
		Monitor and **share industrial crop market price with warning level**
	Office of the civil service commission, Prime Minister's Office	Give out **scholarship on the agricultural related degree** abroad

C. Solutions and movements from Thai private companies and startups[10]

Players in the private sectors are also providing solutions and projects towards the above key agricultural issues, including high production cost, high risk low hedge, low crop quantity, and low crop price. The solutions given by the private companies can be divided into four main types as follows:

1. **Financial and Agri-input supports** such as seed and fertilizer giveaways as well as funding supports
    - The main objective is to provide monetary and input supports to help farmers plant company-related crops.
    - They are mainly providing supports to **their contract farmers, customer farmers, and farmers related to their supply chain.** E.g. Siam Kubota distributes 100 new machines and equipment such as tractors, harvesters, and excavators for rice farmers in 48 enlisted provinces. Also, Thaiwah gives free manure spray fertilizers to farmers.
    - **However, this kind of supports hardly links to the sustainable solutions,** seeing from the repeating short-term supports every year.

2. **Marketing and sales channel supports** such as platforms and marketplace
    - The main objective is to support crop branding & marketing and connect buyers and sellers directly, resulting in higher profit margin to farmers. E.g. FarmTo as B2C marketplace and Freshket as B2B marketplace.

3. **AgTechnology and innovative systems** such as innovative farming, automation, and farm management systems.
    - The main objective is **to improve efficiency and productivity of farming, and to increase crop value by using AgTechnology**
    - Main targets are **smart farmers** with high willingness to pay and knowledge about advanced AgTechnology
    - The providers of AgTech solutions can be divided into 2 groups:
        - **Hardware solution provider:** E.g. Novy provides agricultural drone technology for precision farming, HG Robotics develops the imaging AI to monitor and visualize farming system to reduce risks, Evergrow utilizes automatic fertigation system and watering cycle to increase efficiency
        - **Software solution provider:** E.g. Vdef soft provides a platform to track and forecast future revenue for farmers as well as manage agricultural operations, Ricult provides an application for weather forecast, satellite imagery, record keeping to mitigate farmers' risks and increase crop productions

[10] See Appendix 4 (Table 4-1 and Table 4-2)

4. **Agri-Education**[11]
    - The main objective is to provide know-hows and skills **to mainly solve issues on high production cost, and low crop quality and quantity, resulting in** productivity improvement, capability expansion, and a higher standard of living for farmers in their supply chain.
    - These projects **mainly focus on sharing special techniques and giving advice to farmers in specific areas that relate to their business** or supply chain. E.g. cassava production from cassava processing companies, rice farming supports from fertilizer companies, etc.
    - While the scopes of education supports are **limited to selected numbers of farmers/students in the specific areas, leading to low impacts on solving Agri-issues**
        - Leading agri-food companies are mainly providing education supports to **their contract farmers, customer farmers and farmers related to their supply chain.** However, the number of educated farmers in Thailand is considerably low compared to whole population. According to Office of Agricultural Economics (Ministry of Agricultural Cooperatives), the number of Smart Farmers in 2021 is estimated to be approximately 29,335 farmers, which is extremely trivial if compared with the number of approximately 8,000,000 farmers in Thailand in 2022[12].
        - Startups are also providing some educations and knowledge to **help customers understand their solutions and stimulate demand on AgTechs** they are selling.

Although Thai private firms have made significant efforts to address agricultural issues and help farmers overcome the difficulties, **the problems remained unsolved as nation-wide farmers are still suffering adversely**. Therefore, it can be concluded that these solutions from private companies **do not have notable impacts to solve the current agricultural issues**. Factors behind the failure in solving the ongoing issues will be discussed in the next part of the report.

[11] See Appendix 4 (Table 4-3 and Table 4-4)
[12] Office of Agricultural Economics, 2022

Part 3 – Points to be improved of current solutions

A. Points to be improved in current solutions from Government of Thailand

Government policies and directions

Government of Thailand is currently providing various projects and policies to solve the agricultural issues, but the on-going issues remain unsolved. There are points to be improved as follows:

1. **Government of Thailand is not actively promoting Agtech** solutions to farmers nationwide.
   1.1 The government **does not put priority in the agricultural sector in funding**, compared to other sectors.
   - In terms of the national budget, **the Ministry of Agriculture and Cooperatives had a relatively low budget**.
   - In terms of the local government budget, there are only a few policies in place to foster agricultural development at the provincial level seeing from **limited budgets for agricultural support from each provincial administrative organization**. Under the lack in monetary supports in the local scale, the ongoing issues in the sector cannot be sufficiently solved.

   1.2 The agricultural **budget is mostly allocated to the short-term solutions, rather than** invest and implement for **sustainable long-term solutions.**
   - The government focuses on providing **short-term support to solve issues**, rather than solving the root causes of those problems.
   - From investing most of the budget in short-term solutions, the government **lacks sufficient funding to invest in Agtech solutions that solve agri-issues in the long run**.

2. **The local government lacks information, know-how and resource sharing system, as well as the up-to-date regulatory frameworks** to promote Agtech startups.
   2.1 The government's database has not been shared sufficiently to researchers and AgTech developers in terms of information and resources. Without adequate information and resource sharing, researchers and those who want to develop Agtech may find difficulties to develop products in responding to farmer's needs.
   - Researchers got insufficient supports in terms of information from the government causing them to have low motivation in developing new Agtech solutions. There is limited access for Agtech startups or researchers to useful state-owned information such as satellite, weather forecasts, remaining agricultural stocks, or cashflow of farmer's household information[13].
   - **The government's database is not user-friendly** because it is not aggregated in a single location.

   2.2 The government is inflexible when it comes to adopting new methods, particularly with technologies. The complicated processes and regulations cause obstacles for the widespread adoption and full utilization of Agtech by end users.
   - **The national regulatory frameworks are not conducive to Agtech startup businesses.** The regulations for brand-new products or services are not yet available or clearly stated, therefore, delaying the launch process.

[13] Pier, 2019

        - For example, the rice inspection certification needs to have signature in the lab test from only limited groups of persons authorized by government, even the lab test requires a lot of money and not as precise as AI test from AI rice inspection services.
    - There are **regulations that block farmers' access to technologies** due to the complicated application.
        - For example, to control or operate unmanned aircraft, specific criteria, permissions, and conditions must be met. Individuals who wish to fly drones must obtain a license and register their drone.[14]

Agri-Education

The existing **Agri-education provided by the public a sector do not have remarkable impacts to solve the on-going issues** in the agricultural sector. The supports are vague and not result-oriented; many training programs are held without clear guidelines to achieve the end goal, the successful installation of smart agriculture to nation-wide farmers.

1. **Most agri-education and Agtech utilization projects lack clear indicators** to monitor and achieve the PDCA (Plan-Do-Check-Act) cycle to reach successful installation of smart agriculture in nation-wide farmers.

    - **Key process/performance indicators (KPI) are vague, some are not related to the objective and goals of the program, and some do not show the true results of the project plans.** It can be concluded that the evaluation does not properly measure and lead to the project's success.
    - There is **no exact indicator to measure the long-term success and reflect the effectiveness** of the agricultural education activities**,** thus its outcomes and overall success remain indeterminable.
    - Government's agri-education programs and Agtech solutions lack adherence to PDCA cycle for monitoring effectiveness, rendering them impractical.

2. The training is **impractical due to limitations of the tools and machines provided**. While many projects focus on knowledge sharing that involves teaching on 'how to use technology in farming effectively', a large number of Thai farmers do not have access to those tools to solve their farming issues.
    - It seems that there is a disconnect between the training programs and the availability of AgTech tools for practical trials. While the center organization focuses on increasing the number of local experts and officers to disseminate know-how and technologies to farmers, the training programs at the local level lack in providing tools or AgTechs, greenhouse or sensors in novel farming, to farmers for practical trials.
    - Even in the private sector, the training results cannot lead to successful implementation. For example, Farm Inno, a new agriculture solution-provider under Chia Tai company, provides Drone, Plant factory, and Greenhouse services along with the smart platform aiming to improve farming effectiveness and efficiency under smart agriculture concept. However, farmers are unable to utilize a full capacity of the solutions due to the absence of aftersales or any follow-up services to check the level of understanding of farmers in applying those solutions.

[14] Royal Gazette announced by the Ministry of Transportation under the type of unmanned aircraft, 2015

3. The **Agtech training is not carried down to nation-wide farmers** but only catered to only specific groups.
    - Most Agri-education projects target on farmers throughout the country, however **most courses are passive that require farmers to register to each course**, as a result most courses will provide to a limited number of active farmers with relatively high knowledge and high income. Moreover, since the sessions are passive, there is no method to follow up the practicality of the lessons.
        - Numerous training programs are aimed at government personnel and smart farmers who need to meet specific requirements to enroll. Additionally, several of these training programs are conducted online through the government's division using Zoom, which poses a challenge for farmers who lack internet access and may find it difficult to participate.
    - **The Agtech is not widely recognized by the farmers**. While the government has endorsed Agtech, they may not be aware of the level of utilization among users.
        - Agtech, which can enhance productivity, lower costs, and increase profits, is underutilized due to the knowledge gap and limited internet users in the agriculture sector. Limited digital literacy in the agriculture sector with only 29% of farmers using the internet worsens this situation[15].

B. Points to be improved in current solutions from private company interviews

Agri-Solutions from Thai private companies and startups[16]

According to interview results of Thai private companies and startups, the possibility to penetrate in Thailand is still in the low to moderate level. The main hurdles are **1) the low awareness and affordability of the Agtech among Thai smallholder farmers**, **2) lack of funding in R&D for Agtech providers, 3) Low transparency and outdated system of Government of Thailand**. These solution providers seek high level of both financial and non-financial supports from Government of Thailand.

The first hurdle is to get the **target farmers to be aware of the technologies provided and to have access to the technology**. To extend this, there is only a few communicational supports from Government of Thailand in promoting these technologies to the end users (farmers) while most of the big corporates can adopt the technologies as they have no monetary issues. Even some Agtechs are recognized, but **the initial investment, the risk of changing, and the ROI of AgTech remain a big hurdle for smallholder farmers to try new technologies**.

- For example, EasyRice struggles to reach their target group and advertise their solution because of the low level of trust shared among farmers toward smart technologies.
- For example, Gaorai struggles to provide the one-stop agri-input services which help farmers save cost by using the agri-input more effectively because most individual farmers have limited money for paying before planting. While traditional practice (with higher total cost) allows farmers to use credits on buying agri-inputs and pay back later after harvesting.

The second hurdle is the **absence of large funding for the solution's R&D process**. Investing in technologies requires an enormous amount of funds to test and trial prior to launching the final product which the companies are continuously seeking for external funding to run this R&D procedure.

- For example, Skyviv's yield precision technology has been successfully implemented with the support and funding from the British Government during the R&D phrase.

[15] Application Promotion for Thai Farmers, BOT, 2021
[16] See Appendix 2

- Likewise, EasyRice seeks funding by participating and winning several startup and accelerator awards both in Thailand and overseas.

The last hurdle is the **low transparency and outdated system of Government of Thailand.** As the biggest stakeholder in the agriculture sector, Government of Thailand should lead the industry by setting the example of technology usage. Not only supporting farmers and Agtech providers, but the government itself also has to adopt more Agtech. The government should support Agtech providers rather than slow the development down through **too many requirements and processes that companies must clear those for verification and evidence to prove the feasibility of the solutions.**

- For example, Government of Thailand still adopts the traditional way in agri-crop export order management and certification process. Even many firms provide agri-crop platforms and crop-grading AI services for higher cost effectiveness and more fair system to distribute export orders to nation-wide farmers.
- For example, EasyRice's AI technology must be authorized by the representatives of the Ministry of Commerce which the process requires time and insider connections.

Agri-Solutions from Japanese private companies and startups[17]

According to interview results of Japanese private companies and startups, the possibility to penetrate in Thailand is still in the low to moderate level. The main hurdles are **1) difficulty to find business partners to enter Thai agricultural market, 2) lack of farmers' insight, Thai agricultural information sharing, and implementation support from Thai companies and government.** Some of Japanese private companies also face the problem of **3) difficult distribution of agricultural solutions to nation-wide farmers.** These solution providers seek high level of both financial and non-financial supports from Government of Thailand.

The first hurdle is **the difficulty to find business partners to enter Thai market**. To enter Thai market, information and cooperation from Government of Thailand are required as Japanese companies do not have the connection to Thai farmers. End users' information such as farmer and government's support help Japanese companies who want to enter Thai agriculture market design the business model for testing their product or service in Thailand.

- For example, one of the big Japanese trading companies struggles to acquire business partner especially Government of Thailand. This company approached Government of Thailand via many channels to seek for government's support but there were only a few responses from government which result in the slow progress in entering Thai agriculture market.

The second hurdle is the **lack of farmers' insight, Thai agricultural information sharing, and implementation support**. To enter Thai market, implementation of product test required because farmland in Thailand and crops are different from Japan. Japanese companies need information, know-how and resource of doing agriculture business when they have just entered Thai agricultural market to guarantee that their products can be provided and monetized in Thailand.

- For example, Sagri struggles to acquire the monitored data from doing testing field when Sagri implemented the PoC of their technology in Thailand. Sagri wants the business partner who can provide the testing field and connection with Thai farmers where they can test their product-market fit in Thailand.

[17] See Appendix 3

The last hurdle is the **difficult distribution of agricultural solutions to nation-wide farmers**. Even Japanese private companies can enter Thai market, their product can only reach the big-scale farmers and only specified type of crops (such as high-value fruits). Japanese companies aim to distribute their product to more farmers in every region in Thailand.

- For example, Kao Industrial aims to solve the farmer's issue of inefficient insecticide utilization. They struggle to distribute their products to farmers **because most of farmers do not understand the real value of the Kao's product**. Adjuvant, Kao's agricultural products, increases the absorption rate of insecticide which result in more efficient using of insecticide. Kao needs to sell their product via many tiers of distributors. Distributors cannot explain the value of the Adjuvant to farmers as Kao can do. As a result, only a few farmers understand and purchase Kao's adjuvant to use in their field.

C. Hurdles for agri-solutions usage from farmer surveys

To understand the awareness and penetration of the major solutions towards top agricultural issues in Part 2A, as well as to grasp the hurdles of AgTech penetration in Thailand, we conducted onsite surveys towards 116 Thai farmers and 22 KOL farmers in different regions in Thailand. We asked the farmers and KOLs about the agri-solutions related to their severe agricultural issues as shown in the following Figure 1.

Figure 1: The relationship between the high-priority agricultural issues and the 12 major solutions to solve the issues

To check the farmers' awareness and readiness towards those agri-solutions in the data analysis, the target 12 solutions are grouped into three major solution types (free platforms, mini gadgets, and large equipment) according to their price ranges as shown in Table 6.

Table 6: Division of major agricultural solutions

	Solutions
Type I **Free platforms**	**Application** that helps **manage finance and cost of agriculture** (3)
	Weather monitoring and natural disaster warning **application** (4)
	Online agricultural **trading platform** that **links farmers with the end consumers** (5)
	Online agricultural **trading platform** that **links farmers with factories** (7)
	Software that provides price statistics and quantity needed from historical data to do forecasting (9)
	Platform for selling agricultural products for the **wholesale volume** (10)
Type II **Mini gadgets**	**Surveying drone** that can evaluate and calculate suitable fertilizers (2)
	Marketing company that helps farmers create branding to sell products at higher price (6)
	Product that can help **extend product lifespan** (12)
Type III **Large equipment or tools**	**Fertilizer mixer machine and automatic water dispenser** (1)
	Device that helps classifying and grading the agricultural products (8)
	Controlled greenhouse (11)

The summary of this survey is shown in Table 7. Most farmers do **not aware of free agricultural platform**, while they know the mini gadget and large equipment of agricultural solutions but are not using them.

Table 7: Summary of farmers survey results

Questions	Farmer's representative answer
In these 12 given solutions, which solutions that farmers are aware of and are currently using?	
> free platform	Most of farmers do not know
> mini gadget	Most of farmers know but they not using
> large equipment	Most of farmers know but they not using
Why do farmers know agri-solutions but do not use	
> free platform	They do not use because lack of knowledge about agricultural technology
> mini gadget	They do not use because they have a problem with money and investment
> large equipment	
Why do farmers used agri-solutions but quit using (for farmers who quit using agricultural solution)	Their work becomes more complicated when it could not decrease the cost as they expected
What kind of support that farmers desire to adopt those agri-solutions in their current farming activities (for farmers who do not aware of agricultural solution)	Have someone to provide a close support and give advice

D: Summary of points to be improved and possible solutions from interviews and surveys

The Agtech utilization gaps	Possible solutions
Gaps from the government	
Government is not actively promoting Agtech solutions to farmers nationwide	
National budget provided in agricultural sector is inadequate	Allocate more national budget to MOAC and agricultural related activities
The proportion of local budget on agricultural related is inadequate	Allocate more local budget to agricultural sector from provincial budget
Government invests in short-term rather than sustainable solutions	Allocate monetary support in funding agricultural research and improve Agtech ecosystem
The local government lacks information, know-how and resource sharing system	
Government's database has not been shared sufficiently to researchers and Agtech developers	Aggregate government's data in one single location and open access for Agtech startups and researchers to be accessible to useful state-owned information
Government is inflexible when it comes to adopting new methods	Revise rules and regulations regularly when there is a new adoption on technologies
Gaps from Agri-Education	
Most agri-education and Agtech utilization projects lack clear indicators	
Goals and objectives of the programs has not related to KPIs and measured by vague indicators	Revise the KPI indicators to be measurable
There is no exact indicator to measure the long-term success	Implement quantitative indicator to be able to evaluate the success of the utilization
The trainings have no PDCA cycle to monitor effectiveness	Adjust monitoring system after the programs, courses, trainings are done
Agri-education is limited by the availability of tools and machines provided	
Most of the training programs do not provide Agtech tools	Sponsor Agtech tools to end users together with the training programs
Agtech providers has limited aftersales or follow-up services	Agtech providers need to have aftersales service to follow up and assist farmers with the tools
Agtech training is not carried down to nation-wide farmers	
Most are passive that require farmers to register to each course	Clear out the qualification requirements and open for anyone who interest to join the course
The Agtech is not widely recognized by the farmers	Improve the digital literacy and internet access to farmers
Gaps from Thai private companies	
Target farmers are unaware of the technologies provided	
The communication of Agtech from the government is unreachable	Support free trial and credits for trying new technologies

The Agtech utilization gaps	Possible solutions
There is an absence of large funding for the solution's R&D process	
Government does not provide test and trial funding	Provide R&D funding for Agtech startups
Government process is outdated and slow	
The excessive requirements and processes involved in verifying the adoption of new technologies can slow down the progress	Flexible to technologies adoption and verification to be replaced traditional methods
Gaps from Japanese private companies and startups	
Japanese companies find it difficult to seek for business partners to enter Thai market	
Japanese firms have no connections with Thai farmers	Cooperate Japanese companies to test their product or service in Thailand
The companies have no farmers' insight, Thai agricultural information, implementation support	
Different crops and farmland make it hard to do business model	Provide testing field and connection with Thai farmers to test product-market fit
Japanese companies find it difficult to distribute agricultural solutions to nation-wide farmers	
Can reach to only big-scale farmers and specific type of crops	Train the product distributors on the Agtech to be able to give full information to farmers

Part 4 –Potential supports from JICA towards Thai public and private sectors

A. High-priority agri-solutions that JICA should focus on supporting

The analysis so far has shown that there are **seven high-impact issues found among the nation-wide farmers,** which can be solved by **total of 12 Agtech solutions** (see Figure 2a in Part 3C). Solution-specific assessments were then made in terms of demand level and feasibility level in order to determine which agri-solutions JICA should focus on supporting.

Specifically, the **evaluation of the Agtech potential measured 1) by demand level** from the farmer's need based on their agri-issues and stakeholder's demand (direction from government) and **2) by feasibility level** from the possibility to penetrate from farmer's perspectives and company's perspectives.

On the demand side (scale of 5)

1) **Farmers' demand derived from ranking top solutions** which the scores are from 116 nation-wide farmers and 22 KOL survey and three Agri-expert interviews

- **Farmer and KOL surveys**: scored the Agtech solutions that solve each issue **by the ranking score of high-impact issues they found**.
- **Agri-experts' interviews**: scored the Agtech solutions that solve each issue **by the ranking score of high-impact issues** based on the impact on crop markets.

2) **Stakeholders' demand derived from level of support by Government of Thailand** with three approaches for scoring which are secondary research, 22 KOL survey and 14 local officer interviews

- **KOL surveys: scored from level of support** by local key opinion leaders if they have ever supported the Agtech solution.
- **Local officer interviews: scored from level of support** by provincial agricultural extension officers if they have ever supported the Agtech solution.
- **Research on government's directions**: scored from the level of monetary supports found from the secondary research.

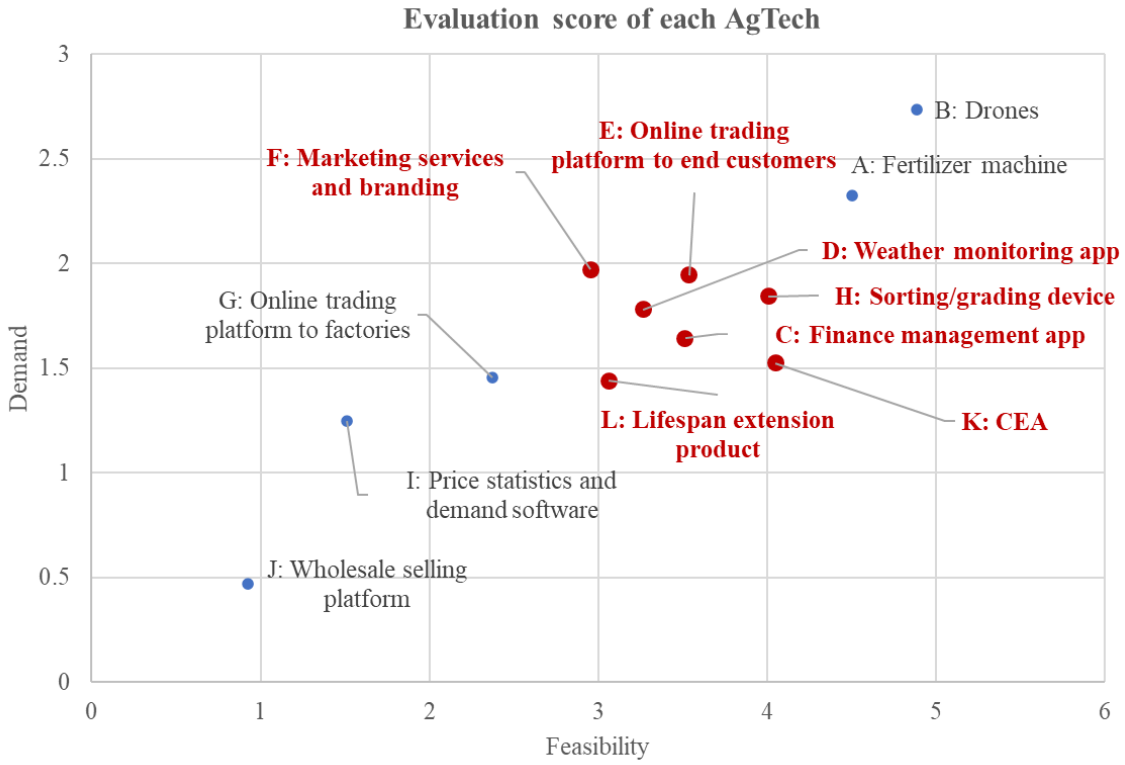
On the feasibility side (scale of 5)

1) **Possibility to penetrate in Thailand** derived from four criteria on two groups which are the farmers and Agtech providers.

- **From farmers' perspective** derived from awareness level and usage satisfaction.
  - **Awareness level from farmer survey:** scored from the awareness level of Agtech solutions that can solve the farmers' addressed issues.
  - **Satisfaction level from current users from farmer survey:** scored from the success rate of solving the issues and cost of implementation.
- **From company's perspective** derived from the value chain success and readiness of the private solution providers.
  - **R&D:** scored from the readiness level in R&D of the solution providers.
  - **Business model:** scored from the capability level in monetize their Agtech.
  - **Sales & aftersales:** scored from readiness level of the sales and aftersales team in expanding and maintenance the Agtech.

Among various types of agri-solutions (AgTech), JICA should focus on the potential AgTech types that match to demand from Thai farmers and government direction, as well as have high feasibility for JICA to help penetrate widely in Thailand. Here we extracted the high-priority AgTech types based on **high demand but low-to-middle feasibility**, representing the AgTechs those have high needs but are inadequately penetrated. The evaluation results showed that the high-priority agri-solutions include following AgTechs;

1. F: Marketing and branding services
2. E: Online trading platform to end customers
3. H: Sorting/grading device
4. D: Weather monitoring app
5. C: Finance management app
6. K: CEA (Controlled environment agriculture)
7. L: Lifespan extension product



B. Possible supports from JICA to public and private sectors

Based on the AgTech provider interviews and research on points to be improved in Part 3, JICA should provide supports to enhance AgTech penetration in Thailand by following approaches;

1) **Thai agriculture information sharing:** Farmers, AgTech developers, and other stakeholders require access to reliable and relevant information about Thai agriculture to make a decision on farming and their business model and strategy designing. **JICA can facilitate knowledge sharing between industry stakeholders** and supporting with **market research, data analysis, and market intelligence** by collaborating with Thai organizations in Table 6 of in the full version of Report of Research and Survey on the Promoting Smart Agriculture in Thailand.
    - For example, there are several websites and applications that provide **agricultural statistics, research reports, policy documents, regulations, articles for knowledge sharing, and agriculture-related news** in Thailand. These resources offer valuable insights into production, trade, and other important indicators related to agriculture. Some of the key websites and applications include the Thai Rice Exporters Association, the Thailand Board of Investment, and the Thai Organic Agriculture Association.

- For further AgTech penetration, **technology transfer and capacity building** are essential for improving the productivity and profitability of farmers and agribusinesses in Thailand. There are several organizations that **provide training and technical assistance** to farmers, extension workers, and other stakeholders to help them adopt and implement new technologies and practices. Some of the key organizations include the Thai Agricultural Extension and Development Foundation, the Thailand Research Fund, and the Thai Farmers Association.
- In addition, **market information and trade promotion** are critical for the success of agriculture businesses in Thailand. There are several organizations that provide market intelligence, **export development, and investment promotion services to support Thai exporters**. The Department of International Trade Promotion, for example, organizes and participates in a variety of trade fairs, exhibitions, and business matching events, both in Thailand and overseas. The Thai Rice Exporters Association also provides reliable information and data on the rice trade at national and international levels.

2) **Platform for business partner finding:** JICA can help new entrants to find suitable business partners in both the public and private sectors, enabling **collaboration for product research and development, testing, and marketing and sales activities**. This will be particularly valuable for new entrants who may not have established networks in the Thai agriculture industry.
    - Online platforms are increasingly being used to **connect farmers, agribusinesses, and other stakeholders** in the agriculture industry. There are several online platforms that allow members to connect with each other, find potential business partners, connect farmers with buyers and suppliers, and provide digital marketplaces and logistics and distribution services. They also organize networking events, business matching activities, and seminars for members. Some of the key platforms include the Thai Agriculture Marketplace, the Thai Organic Farmers Association, and the NSTDA Connect (Table 6 of in the full version of Report of Research and Survey on the Promoting Smart Agriculture in Thailand).
        - For example, it is worthwhile for training programs to explore ways to provide farmers with access to advanced AgTech, such as through partnerships with AgTech companies, or by offering shared facilities where farmers can experiment with these technologies.
    - In addition, **funding to enhance research & development of AgTech for smallholder farmers** is also required. AgTech providers require funding and collaboration to drive innovation and develop AgTech solutions that are suitable for smallholder farmers. Such solutions should be low-cost, easy to implement, and provide a quick return on investment, as smallholder farmers may have limited financial resources. Some of the key organizations playing a key role in AgTech funding include Board of Investment Thailand (BOI), Thailand Research Fund (TRF), National Innovation Agency (NIA), National Science and Technology Development Agency (NSTDA). Please see further details in Table 6 in the full version of Report of Research and Survey on the Promoting Smart Agriculture in Thailand.
        - For example, providing financing or subsidies to farmers could help them invest in AgTech tools that could improve their productivity and profitability with monitoring systems to ensure the success of AgTech utilization.

3) **Knowledge and best practice sharing about how the Japanese government and Japanese smart agriculture companies have successfully supported AgTech penetration in Japan:** By leveraging the expertise, resources, and networks, JICA can help promote knowledge and best practice sharing about how the Japanese government and Japanese smart agriculture companies have

successfully supported AgTech penetration in Japan. This can contribute to the sustainable development of agriculture in Thailand.

- JICA can conduct **research on the policies, programs, and initiatives implemented by the Japanese government and Japanese smart agriculture companies** to support AgTech penetration in Japan. The findings of this research can be shared with other countries to help them design and implement similar initiatives.
- JICA can organize **workshops and seminars to share best practices and experiences with policymakers, experts, and stakeholders** from other countries. These events can provide a platform for knowledge exchange, capacity building, and networking.
- JICA can provide **technical assistance** to organizations that are interested in learning from Japan's experience in supporting AgTech penetration. This can include support in **the areas of policy development, program design, KPI and monitoring system design, and project implementation and follow-up practice**.
- JICA can **facilitate partnerships between Japanese AgTech companies and organizations and their counterparts** in Thailand. These partnerships can help transfer technology, knowledge, and expertise to Thailand and promote the adoption of AgTech.
- JICA can **support pilot projects to test and evaluate the effectiveness of different AgTech solutions** in different contexts. This can help identify best practices and lessons learned that can be shared with other countries.

Overall, JICA can play critical roles in supporting the growth and development of the AgTech industry in Thailand, by facilitating knowledge sharing, enabling collaboration between stakeholders, and providing knowledge and best practice from Japan to support practical AgTech penetration in Thailand. For further details of organization who are providing Thai agriculture support, please see Table 6 of the main report