Smart SEP Farmers: Digital Platform to Enhance Farmer Life Sustainability According to Sufficiency Economy Philosophy

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Abstract

This research creates a network of "Smart SEP Farmers" on the digital platform SEPAction to elevate the Sufficiency Economy Philosophy (SEP) of target farmers from the level of "Action" to "Attain" to "Achieved." 312 farmers in 9 provinces in the northern region of Thailand have joined this project. A farmer can evaluate themselves to see their weakness, so they can plan to improve themselves following the Farmer's Success Level guild provided to make an effective farmers community. After using this application, we found that the target farmers potential are increased by 31.29% which come from 169 farmers can improving from a qualify farmer to the farmer in the Act level who know how to make a successful work in their careers, together with 118 farmers who can improving from Act level to Attain level know what is good or bad along their career path to meet self sufficiency, and together with 4 farmers who can improving from Attain level to Achieved level who can improve their product by themselves. More than that, we found that the farmers reduced agricultural expenses by 21.44% and can reduce debts up to 19.74%. We also showed the evidence to improve well-being and solve poverty among farmers genuinely. Results discussion, cooperation guidelines among the government sector, academic agencies, and farmers, and future improvement strategies are also stated to make sustainable smart farming.

Keywords: Smart farming, Philosophy of sufficiency economy, Sustainable agriculture, Digital technology, Thailand

1 Introduction

Agricultural products are one of the most important sources of income for many countries. Many countries have introduced various technologies to make agrarian production as efficient as possible. In [1], Arslan et al. use data related to climate-smart architecture to estimate the impacts on maize yields in Zambia and agricultural products in South Africa, respectively, to fix climate factors and improve agriculture. In [2], Filipe et. al. proposed the energy control and technology for adequate energy management in the rural farms in Portugal, which are energy-intensive and have low energy efficiency. In [3], Sjaak et. al. proposed an article to review the current state of big data applications in smart farming and identify the associated socio-economic challenges. It shows that using information plays a significant role in enhancing farmers' decision-making accuracy. In [4] Walter et. al. discusses the limitations of traditional plant growth data measurement methods, which rely heavily on human labor and are prone to high variability compared to their proposes a novel approach using intelligent farm robots equipped with RGB-D cameras and deep learning techniques for object detection and image fusion, enabling accurate and automated measurement of plant growth data. In [5], Rambod et. al. summarize the overall landscape of digital technology applications in agriculture (DA). The authors state multiple technologies, such as IoT, AI, blockchain, Cyber-Physical Systems (CPS), Decision Support Systems (DSS), and big data, and discuss the real-world implementation challenges related to farming. Future directions and policy recommendations are also recommended. In [6], Mohd et. al, discusses the adoption of Agriculture 4.0 technologies to enhance smart farming, focusing on improving efficiency, promoting sustainable resource use, and leveraging big data in combination with IoT, AI, machine learning, drones, sensors, and more by proposing FarmBot Network which is a concept to get more efficient, productive, and profitable farming. So, as in [7-8], the authors review a concept for developing an "integrated smart agricultural system" by leveraging a combination of digital technologies such as AI, IoT, Blockchain, Edge, and Cloud computing on traditional agricultural management into a more innovative and sustainable system through integrating digital technologies. The aim is to enhance the efficiency of data collection, analysis, sharing, and utilization in agriculture. It also improves productivity, sustainability, decision-making capacity, and the resilience of agricultural systems to environmental and societal changes.

The government and educational sector also have a role in farming development and improvement. In [9], Nikolova M. demonstrates that government support is a key mechanism in enhancing the competitiveness, sustainability, and growth of small and family farms in Bulgaria. They play a crucial role in providing financial support, implementing structural measures to enhance the

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efficiency of the supply chain, strengthening the domestic market, and promoting young farmers and resilience during crises. In [10], Michael and Gregory state that government and private sector initiatives promote smart farming through long-term policies and practical solutions to Small-scale farmers' problems. Technologies like Handy Sense and Farm Man Yum systems have been implemented successfully, helping reduce costs and increase productivity. Major telecom providers like DTAC, AIS, and TRUE also offer IoT platforms to support smart agriculture. In [11], Susan et. al. compare the development approaches of "smart farming" between the United States and South Korea, focusing on social, economic, technological, and policy factors driven by both public and private sectors to promote sustainable agriculture. The findings reveal that South Korea adopts a nationally planned approach led by the government whose formulating national-level strategies, such as the Digital Agriculture Plan and Smart Farm Innovation Valley, supporting the development of holistic smart farming communities, promoting domestic innovation, reducing reliance on foreign technologies, and driving public policy initiatives to boost rural economies and attract younger generations can expanding access to technology for smallholder farmers, encouraging community-level sustainability, and accelerating the creation of an agricultural ecosystem with a well-structured support system. In [12], Federica and Eugenio investigated the role of education, farm size, farm types, to perceive barriers in adopting the use of Smart Farming Technologies (SFTs) in a sample of Italian farmers from the Piedmont region (North-West Italy). The study showed that low levels of education and working on-farm alone were positively associated with perceived economic barriers to adopting SFT. In [13], Iba and Lilavanichakul state the government's role in preserving agricultural land in hilly and mountainous (HM) areas in Japan. The government supports infrastructure, financial, and technology to prevent farmland abandonment and encourage the adoption of Smart Farming Technology (SFT). SFT helps reduce labor burden problems of aging farmers, increase accuracy and efficiency using resources, boost income and reduce costs. In [14], Jennie investigates the barriers to implementing sustainable business model innovation (SBMI) in the agricultural sector of Sweden. The paper found that Farmers understand the need for change but still lack tools and knowledge, and a transformation must start from within, particularly by strengthening leadership skills. The paper also recommends promoting SBMI knowledge through training programs and national policies. In [15], Kwanmuang et. al. examine the policies and approaches for implementing innovative farming systems among small-scale farmers in Thailand. Its objective is to enhance production efficiency, reduce costs, and promote sustainability in the agricultural sector challenges such as labor shortages, an aging farming population, and economic and environmental uncertainties. The article highlights the necessity of supporting small-scale farmers through policy initiatives, research, training, technology access, and the development of strong networks. It also presents examples of successful projects and case studies in technology adoption, such as the automatic water control system and the Handy Sense system. The development of smart farming in Thailand is driven by the collaboration of three key sectors in a "tripartite partnership" model: Government: Formulates policies, provides promotion, and offers support, Academia/Research: Develops technologies and conducts training, Business Sector: Applies the technologies in practice and creates accessible systems and services.

From the previous studies mentioned, modern agricultural development increasingly incorporates various technologies. The success of using digital platforms to drive intelligent farmer networks differs across countries. However, most research outcomes related to increasing productivity, boosting profits, and reducing problems tend to be implemented only among groups of farmers with similar characteristics. Nevertheless, there is still a lack of research that utilizes technology to guide policy-level operations to develop diverse areas from upstream to downstream, to achieve truly integrated and sustainable agriculture. This research proposed the Smart SEP Farmers Project to acknowledge farmers with Sufficiency Economy, together with the cooperation among the government sector, academic agencies, and farmers, to yield sustainable communities.

Chapter II states the origin of the smart SEP farmer project, the smart SEP farmer development plan, the farmer's evaluation guidelines, the ecosystem, and the application design. The results and conclusions of this project are stated in Chapters III and IV.

2 Smart SEP Farmers

The SEPAction project is a digital platform developed from 2018 to 2020 under the domain name https://SEPAction.com. It has the primary objective of driving the Sufficiency Economy towards sustainable practices and to disseminate information widely both domestically and internationally to spread the honor of His Majesty the King, His Majesty Bhumibol Adulyadej the Great, who was the first leader in driving the sufficiency economy in Thailand and around the world. A website is an important channel to increase the potential to connect information among individuals, government organizations, and businesses. Everyone can access it equally, conveniently, anytime, and anywhere. To develop Thailand's agricultural sector to be efficient and sustainable, the researcher applied modern technology, such as a website, which is easy to access. Users can easily access and use their time to study more quickly. It is also a center for collecting work, activities, projects, and research results. Also, it serves as a source of information and techniques for applying the Sufficiency Economy Philosophy (SEP) to those interested in studying, researching, and using the knowledge.

To focus on farmers to have a sustainable application of knowledge about SEP to improve themselves until reaching the goal, to be the model farmer of their community, the researcher separated the sector of SEPAction project to the website www. smartsepfarmer.

com, and call this the "Smart SEP Farmer Project". The researchers also expanded the project from using a website to a mobile device platform. To increase user convenience and to focus on Smart SEP Farmers with smartphones. The development of the mobile platform is on Android operating systems from version 5.0 and up (currently version 13), which can support all devices that farmers participating in the project are using. To engage farmers who lack knowledge and understanding of digital platforms, we classify farmers according to their level of digital technology proficiency to be effective in transferring knowledge. To reduce the problems that most elderly farmers who live on high ground cannot access information about technology, we create a new generation of farmers to replace the old one. Young Smart Famers with easier access to technology can help pass on knowledge and understanding to the previous generation of farmers. Motivate farmers by spotlighting those who are successful in smart agriculture. These farmers can motivate, educate, and help convey the message to each other according to community guidelines. We expanded the original 30 farmer groups from a network of 6 provinces in the upper northern region in Phase 1 to another 30 farmer groups in Phase 2. It has been expanded to a network of 9 provinces, and the total farmers who joined phase 2 is 312.

To make the Smart SEP Farmer project successful, only farmers who want to join the project are selected. The farmers must intend to do and join the project, ready to improve themselves, accept feedback, earn income, reduce expenses, reduce debt, and adopt the Sufficiency Economy. The project also determined that the selected innovative farmer should have knowledge and understanding of the use of innovative technology. In the process, farmers need to do a first self-assessment to evaluate the level of sufficiency of the economy in the Smart SEP Farmer Platform. The system will display the assessment results to farmers so that each farmer can know their sufficiency level, and they can plan improvements. Farmers can improve their information in the Smart SEP Farmer Platform and conduct a second self-assessment to compare development results, and also see plans to enhance production. This platform can help farmers know their weaknesses, so they will know what to improve. The farmers can repeat the self-assessment through the Smart SEP Farmer Platform until their goals are achieved, to become a model farmer for the communities.

The research team and another working group of 10 agencies: 1) Office of Agricultural Research and Development, Region 1 2) Office of Agricultural Economics No. 1 3) Department of Local Administration 4) Rice Seed Center 5) Bank for Agriculture and Agricultural Cooperatives 6) Industrial Promotion Center Part 1, 7) Public Relations Office, Region 3, 8) Community Development Department, 9) Provincial Commerce Office, and 10) Provincial Public Health Office (Public Health Office) will collect data and feedback from the self-assessment of each farmer in the area, together with the information received from the focus group interviews to see the results of farmers' improvement before leading to action planning to focus on the need of farmers according to the Sufficiency Economy guidelines. The Smart SEP Farmer Platform will show the problematic dimensions and synthesize, helping the government sector to design appropriate projects for each farmer group, which are different. However, administrative organizations in each area have different understandings of SEP and apply SEP according to their knowledge. To develop the country's farmers' growth in the same direction, we must first control the understanding of SEP of the local administrative organizations in the same way.

2.1 SEP and the Development Planning

Sufficiency Economy Philosophy (SEP) is a philosophy that points out the way of life and conduct of people at every level; the family, the community, or the state.

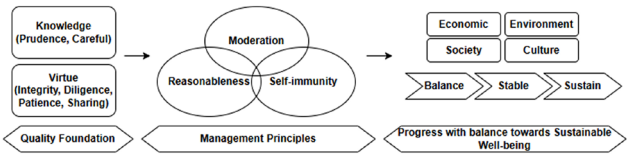

Figure 1. Sufficiency Economy model

From the SEP model [16-17], Figure 1, knowledge consists of prudence and carefulness. When interpreted more clearly, the word knowledge means intelligence. The words prudence and carefulness mean mindfulness. Hence, "*knowledge*" in the SEP should be defined as "Intelligence controlled by mindfulness." Therefore, according to SEP, people's qualities should be interpreted as "*the one with intelligence together with virtue*." After finding a quality foundation person, we have to follow the management principles of bringing results according to the guidelines of SEP, which include "*Self-immunity*," "*moderation*," and "*reasonableness*."

• ***Self-immunity*** can be compared to when a person has a "method" to survive an undesirable situation. They know how to make a successful work in their careers. This means the person has a "*Way of implementation*" to protect themself.

• ***Sufficiency or moderation*** can be compared to when anyone has a "*way of thinking*" to know the best point of living, which is not too much or too little. They can adapt to conflicts or changes to make their life stable. The best point of each person's life can be different according to the sufficiency of each person.

• ***Reasonableness*** is not logic in mathematics with a fixed answer. However, the reasons for this are from the Buddhadharma, namely cause-factor-effect. If you want good results, you must create good causes and good supporting factors to get good results. This also follows the natural logic of darkness, light, heat, and cold. The natural reasoning is not black and white, but it will be gray in various ways, such as from gray with 0% black, which is white, to the shade of gray that is darker than this, 1% and 2% of black up to gray with 100% black, or completely black. As well as suffering and happiness. This can be compared to anyone with a reasonable way of thinking, and it can become a "*way of life*", yielding a sustainable

good effect. Therefore, having reasonableness is the highest level of SEP.

According to the sustainability development proposed by the United Nations (UN), [18] "*balanced*" can yield a sustainable economy, society, environment, and culture. When everything is in balance, it will be stable. And when it is stable, it will be sustainable. However, in the Buddhist Dhamma, nothing is sustainable according to the Three Characteristics Law, which is the three characteristics of anything. Consisting of impermanence, dukkhaṃ, and anattā. Everything changes all the time due to internal and external pressures. When that happens, it becomes impossible to hold on to anything permanently. Therefore interpret the meaning of the word sustainability arises from those farmers with intelligence and virtue, balance in using their knowledge to pursue a career that can support themselves and their families, be able to adapt to various changes so that they are not too negatively affected. They can use knowledge for a balanced career, and know the best point in life. At this point, the farmers will not be impacted much by problems or sufferings, and will be happy. Therefore, freedom from suffering is happiness, which is more important than sustainability. However, suppose happiness happens to an individual or a group while many people are still suffering, the already happy group may not feel "*secure*" because how can they be happiness in the midst of suffering? Therefore, we should also help others as much as possible to create a happy community, which can make one's life secure. Thus, we should create happiness for others by giving knowledge can help others see a way to solve problems or change the way of thinking and working yields community peaceful and happy life. To complete these, we need to provide methods, including resources, such as training and funding, so that the person receiving help can learn and eventually help themselves. This can make the whole community happy. Note that givers should not wish to receive anything in return. If you hope to get something in return, you will naturally have desires in return for giving. And if hope is not fulfilled, it will become suffering instead of happiness. As the SEP definition aims to improve farmer life until the whole farmer's community is happy, we separated the farmer development level as shown in Table 1.

Farmer's Success Level are divided into four levels: The "***Quality Foundation***" is for farmers with intelligence and morality. This is the minimum number of qualified farmers who can join the project. After these farmers evaluated to understand the facts or the ways of successful growth of their product and have stable work, they are counted for the "***Act Level***", the prudence farmer who knows how to balance the way of implementing, successfully growing plants, which can make their work happily because they have products to be sold. After they have successfully taken action and gained enough experience to identify what the good ways or what are the bad ways to make them get the successful product, they can move up their level to be the "***Attain Level***", the moderate farmers who know which factors are appropriate to grow plants successfully. This makes them always grow plants with many products and have a sustainable, happy life. After they find the stable process to transform input factors to get the successful output product factor and share their result to others to let them follow the success to make others life better, the farmer will reach the goal of the project and count for the "***Achieved Level***", the reasonable farmer is willing to share their successful knowledge to others, to make their life and the whole community secure and happy.

Table 1. Farmer's success level

Level	Name	Details
1	Quality Foundation	Moral Farmer with Intelligence and Consciousness
2	Act Level Process	Prudence Ways of implementation: if A, do A', if B, do B'
	Act Level Output	Happy Work: Balance
3	Attain Level Process	Moderate Ways of Thinking: What is good, what is bad, what is proper
	Attain Level Output	Happy Life: Sustainable
4	Achieve Level Process	Reasonable Ways of Life: It turns out to get the results like this because of A, B, and C. We should do A because we want the result A'
	Achieve Level Output	Happy Community: Secure

We define Smart SEP Farmers as farmers who practice agriculture according to the new theory of organic farming or other sustainable agriculture, and use modern knowledge, including machinery or modern agricultural technology that is appropriate according to SEP. The role model farmer or the farmer who gets the Achieve Level for the Smart SEP Farmers should be able to increase agricultural potential, improve production efficiency, reduce production costs, create additional value, increase income, reduce debt, and escape poverty. However, before a farmer can reach the goal, we level the farmer according to their knowledge, let them test themselves to see their strong and weak points, and provide them with the way to go.

2.2 Evaluation Design

The Bio-Circular-Green (BCG) Model has been approved as operating guidelines by the Cabinet of Thailand on 10 January 2021 to drive the economic development of Thailand to change Thailand's agricultural system to 3 high levels: 1. high efficiency, to use technology and innovation. 2. high standards, to raise agricultural products that cover quality, nutrition, safety, and sustainable production systems. 3. High income, to produce various agricultural products, emphasizing premium quality for a higher price. This will result in a balanced and stable Gross Domestic Product (GDP) growth in the agricultural sector. The BCG model is believed to enable sustainable development goals (SDGs) by promoting sustainable agriculture, clean energy, responsible consumption and production, ensuring biodiversity conservation and sustainable utilization, and protecting the environment and ecosystem. [19] Thus, we combined SEP with the BCG and proposed the model to measure the level of success as a guideline in four dimensions. The first three are based on the three dimensions of the BCG model (Bio Economy, Circular Economy, Green Economy), and the last one is based on the sustainability of SEP (Network).

• ***Dimension 1 Bio-Economy*** refers to farmers' intelligence level in innovation and technology, as well as the value added to production by renewable biological resources and the conversion of these resources into value-added products.

• ***Dimension 2 Circular Economy*** refers to the efficient use of natural resources (Efficiency). The effective use of natural resources. (Effectiveness) and having productivity (Productivity) of reusing and recycling resources

• ***Dimension 3: Green Economy*** is determined to keep the economy, society, and the environment in balance, leading to sustainable development. To make a production that is friendly to the environment. Environmentally friendly processing and responsibility to consumers.

• ***Dimension 4: Network*** refers to establishing a production, marketing, and organization network to make a sustainable community.

We designed questionnaires to assess farmers according to the four dimensions above. Each level of evaluation also corresponds to the three Farmer's Success Level proposed in section 2.1 and the group corresponding to pyramid of learning of Bloom's taxonomy: remembering and understanding level, applying and analyzing level, and evaluating and creating level [20]. The level of farmer evaluation is:

• ***Smart SEP Farmers Level 0***, a level not eligible for Smart SEP Farmers, refers to farmers who practice monoculture and use chemicals, including pesticides and chemical fertilizers, at all production levels.

• ***Smart SEP Farmers Level 1***, the Act Level, the level that qualifies as Smart SEP Farmers, refers to farmers who practice integrated farming in various forms. Modern technology is used appropriately. Even though chemical fertilizers are used, they are safe for agriculture. It is not harmful to the farmers and consumers, as it is non-toxic agriculture. The farmers do not have debt burdens that exceed their ability to repay debts within a reasonable time. To achieve the Act level, the farmers have to have the skills to understand and remember to operate their carrier. They also have to have self-immunity to keep their job success.

• ***Smart SEP Farmers Level 2***, the Attain Level, refers to farmers who produce products without chemicals or are entirely organic. They use biological substances they can create or obtain from procurement without unnecessarily high costs. The farmers live happily without debt. To achieve the attainment level, the farmers have the skills to apply and analyze their knowledge to make a moderate and balanced way to produce their product efficiently.

• ***Smart SEP Farmers Level 3***, the Achieved Level, is the level that achieves the Smart SEP Farmers objective, which means farmers who are stable, ready to share knowledge with others, or operate in the form of a learning center. They are role models who disseminated and expanded knowledge to other groups of farmers. These farmers must have the skills to evaluate and create a new way of learning that returns an efficient result and become our model farmers.

Smart SEP Farmers has the framework of assessment indicators at each level in 4 dimensions, and each dimension has two indicators, as shown in Table 2. Each dimension is worth 100 points, 400 points in total. We let farmers evaluate themselves by using 10 Likert scales. Farmers must pass 80% of the Act Level questionnaires to achieve the Act Level. After they get the Act Level, they have to pass 60% of the Attain Level questionnaires to achieve the Attain Level. And after they get the Attain Level, they must pass 60% of the Achieved Level questionnaires to achieve the Achieved Level.

Table 2. Smart SEP Farmer assessment questionnaire

SEP	Act Level Ways of implementation	Attain Level Ways of Thinking	Achieve Level Ways of Life
Bloom Taxonomy	**Remember, Understand Level**	**Apply, Analysis Level**	**Evaluate, Create Level**

Dimension 1 Bio-Economy	**Level of knowledge of farmers**	**Level of Innovation and technology**	**Level of value creation**
Indicator 1.1 (50 points)	**Knowledge level in agricultural management**	**Innovation and technology in agrarian management**	**Value creation level in agrarian management**
	(1) Production of the architectural input (10 points)		(1) Added value in the production of the architectural input (10 points)
	(2) Dependence on household labor or social partnership support (10 points)		(2) Can manage household labor and networks (10 points)
	(3) Processing of agricultural products to gain more value (10 points)		(3) Added value in agricultural production processing (10 points)
	(4) Processing of surplus agricultural inputs (10 points)		(4) Added value in processing surplus agricultural inputs (10 points)
	(5) Accounting is used in production planning to reduce production costs. Able to reduce agricultural debt by at least 30% (10 points)	(5) Accounting is used in production planning to reduce production costs. Able to reduce agricultural debt by at least 50% (10 points)	(5) Accounting is used in production planning to reduce production costs. Able to reduce agricultural debt by at least 80% and other debts by at least 20%. Also, they can recommend reducing debt planning to others. (10 points)
Indicator 1.2 (50 points)	**Level of knowledge in basic developing innovations**	**Level of knowledge in applying innovations**	**Level of knowledge in creating innovations**
Note that the total is not more than 50 points	(1) Labor saving (10 points)		
	(2) Energy saving (10 points)		
	(3) Pest control (10 points)		
	(4) Inspection of water status and soil quality (10 points)		
	(5) Aerial survey to find abnormalities (10 points)		
	(6) Packaging and transportation (10 points)		
	(7) Plant or animal production (10 points)		
	(8) Post-harvest management (10 points)		
	(9) Processing of architectural input and output (10 points)		
	(10) Other aspects of agriculture (10 points)		

Dimension 2 Circular Economy	**Efficient use of natural resources**	**Effective use of natural resources**	**Productivity improvement**
Indicator 2.1 (50 points)	**Integrated farming**		
	Integrated farming system (at least two types of plants or animals) (50 points)	Integrated farming system and apply both plants and animals. (50 points)	Pattern of using combined production factors of both plants and animals in an organic production (50 points)
Indicator 2.2 (50 points)	**Beginner level of architectural resource management**	**Intermediate level of architectural resource management**	**An advanced level of architectural resource management**
	(1) Soil improvement (10 points)	(1) Soil improvement in the good agricultural practices system (10 points)	(1) Soil improvement in the organic farming system (10 points)
	(2) Water improvement (10 points)	(2) Water improvement in the good agricultural practices system (10 points)	(2) Water improvement in the organic farming system (10 points)
	(3) Production of plant or animal varieties for use (10 points)	(3) Production of plant or animal varieties for use in the good agricultural practices system (10 points)	(3) Production of plant or animal varieties for use in the organic farming system (10 points)
	(4) Production of organic fertilizer/compost/ hormones/biological fermentation liquid (10 points)	(4) Production of organic fertilizer/compost/ hormones/biological fermentation liquid in the good agricultural practices system (10 points)	(4) Production of organic fertilizer/compost/ hormones/biological fermentation liquid in the organic farming system (10 points)
	(5) Sufficient reliance on household labor in the agricultural sector. (10 points)	(5) Sufficient reliance on exchange labor in the community. (10 points)	(5) Sufficient reliance on exchange labor inside and outside the community. (10 points)
Dimension 3 Green Economy	**Environmentally friendly production**	**Environmentally friendly processing**	**Responsibility towards consumers**
Indicator 3.1 (50 points)	**Agricultural production pattern**		
	(1) Begin changing to the good agricultural practices system (50 points)	(1) Begin changing to the organic farming system, or is in the process of applying for the organic farming system standard certification, or has good agricultural practices (GAP) certification (50 points)	(1) Apply an organic farming system (has organic agriculture certification) (50 points)

Indicator 3.2 (50 points)	**Environmentally friendly production standards and product warranties to consumers**		
	(1) The product has been certified by the Community Product Certification Standards (CMU) (50 points)	(1) The product has been certified by Good Manufacturing Practice (GMP) or the Food and Drug Administration (FDA). (50 points)	(1) The product has been certified by the Food and Drug Administration (FDA) or has nutritional analysis results from a laboratory (Nutrition Labeling) (50 points)
Dimension 4 Network Action	**Production Network**	**Marketing Network**	**Organizational Network**
Indicator 4.1 (50 points)	**Can set up their farm as a learning center for production**	**Can set up their farm as a learning center for production and marketing**	**Can set up their farm as a community of learning centers**
	(1) Farmers can concretely set up their farms as learning centers for production. (25 points)	(1) Farmers can concretely set up their farms as learning centers in production and marketing. (50 points)	(1) Be a host or set up their farm as a learning center between communities with certifying agencies supporting, and also have continuous operations (50 points)
	(2) Farmers can join groups of community members to set up learning centers concretely. They have continuous operation and have been certified as an establishment of the learning center (25 points)		
Indicator 4.2 (50 points)	**Level of support in production**	**Level of support in marketing**	**The level of support at the organizational level**
	(1) Knowledge and expertise in agricultural production (10 points)	(1) Has a community enterprise group (50 points)	(1) Farmers support each other in the community. Form a strong group. Join as an organization network with external groups (such as government organizations or private sector organizations, etc) (50 points)
	(2) Architectural input (10 points)		
	(3) Labor aspect (10 points)		
	(4) Agricultural machinery (10 points)		
	(5) Savings or credit groups for agricultural production (10 points)		
Points	**≥ 80%**	**≥ 60%**	**≥ 60%**

2.3 Ecosystem Design

To make this project sustainable, the four sectors, the government sector, academic agencies, model farmers, and regional farmers, need to cooperate as Figure 2;

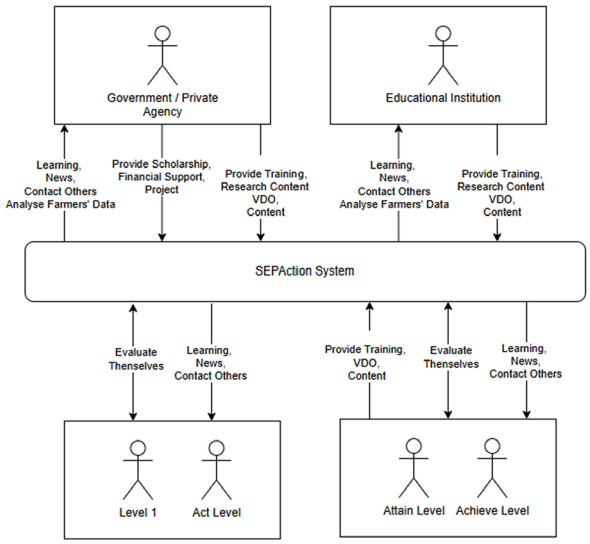

Figure 2. Smart SEP Farmer Ecosystem design

2.3.1 Government Sector

Smart SEP farmer ecosystem design requires government agencies and policy drivers. The government will cooperate with various agencies in the area, and every agency must drive the main policy level to help farmers raise the standard of smart SEP Farmers. ***Local administrative organizations*** that work closely with farmers in their area must adopt policies to support upgrading farmers' abilities. Government agencies can use data collected from the smart SEP farmer system to analyze the strengths and weaknesses of individual farmers in sub-districts and provinces. This allows government agencies to know the issues the organization must address to help and support farmers in a specific area, which may differ from the other areas. This can help local administrative organizations manage this budget effectively and improve the livelihood of farmers according to the actual needs of the farmers.

2.3.2 Academic Agencies

Academic agencies such as local researchers, educational institutes, and various universities will build an academic and research team and expand the scope of research to all regions of Thailand. Universities will change the complex academic knowledge into simple digital media such as infographics, video clips, or easy guidebooks to help create farmers' knowledge and let the farmers have easier ways of learning and gaining knowledge.

2.3.3 Model Farmer

Most of the people in the local administrative organizations are model farmers. To have agricultural development reach the highest level of SEP to increased income, decreased expenses, or even increased ability to repay debt of the farmers in the region, model farmer have to cooperate with local administrative organizations and local universities to improve the efficiency of public agricultural services including creating and developing simple agricultural innovations according to SEP or BCG guidelines for farmers in the area. Model farmers need to increase their skills in transferring knowledge of various technologies to lead the regional farmers to be smart SEP farmers. In this project, the model farmers have to show their successful agricultural production and successful factors and processes online to create a network of online communication via the smart SEP farmers platform, which the farmers can access anywhere, anytime, and there is a lot of support.

2.3.4 Regional Farmers

Farmers, especially the new generation of farmers or young smart farmers who are alert and understand smart agriculture, can help drive the Smart SEP Farmers project very well. This project provides a mobile application channel where farmers can create a channel to exchange knowledge about agricultural production with other farmers through the network. Farmers can rely on themselves to acquire knowledge and keep up with changes in the world of technology. It also provides farmers with more channels to contact the network, increasing the potential and cooperation of community businesses. Presenting SEP information can drive SEP into practice and will create a strong farmer network in the future. At the same time, farmers will also be able to evaluate themselves to know their direction of action. They can also develop their production according to the guidelines to upgrade to reach the highest level of the Farmer's Success Level.

2.4 Application Design

We need tools to cooperate with the four sectors in section 2.3 to drive the Smart SEP Farmer ecosystem. Local administrative organizations should check farmers who will join the project, and after that, the Member IDs will be created. Farmers have to confirm their identity to avoid scammers. The farmers can evaluate themselves and compare them to the previous evaluation. They can also see the role model farmer evaluation result and keep a favorite to follow their idols. Search also includes generating a farmers' community, including the community of the same area farmers and the community of the same product. The user requirement specification (URS), which shows how farmers can use the smart SEP farmer system, is as follows.

- ***URS-001*** Farmers shall register by using a Smart SEP Farmers ID or by providing their information before using the Smart SEP Farmers Platform
- ***URS-002*** Farmers shall view a list of Smart SEP Farmers in each province. (Figure 3)
- ***URS-003*** Farmers shall view role model farmer information, their videos, and their shared works. (Figure 4)
- ***URS-004*** Farmers shall view the evaluation results of the Smart SEP Farmers in each province. (Figure 4)
- ***URS-005*** Farmers shall search for the names of Smart SEP Farmers. (Figure 5)

- ***URS-006*** Farmers shall save the names of Smart SEP Farmers. (Figure 6)
- ***URS-007*** Farmers shall conduct an assessment using Smart SEP Farmers assessment questionnaire. They can view the evaluation results at the individual or provincial levels. (Figure 7)
- ***URS-008*** Farmers shall see the guidelines for evaluating the operations of farmer groups to move from the Act level (orange circle), to the Attain level (green circle), and to the Achieved level. (blue circle). (Figure 7)
- ***URS-009*** Farmers shall edit their information. (Figure 8)
- ***URS-010*** Farmers shall compare their first and second evaluation result. (Figure 8)

The user interface (UI) of the smart SEP farmer application is shown as follows;

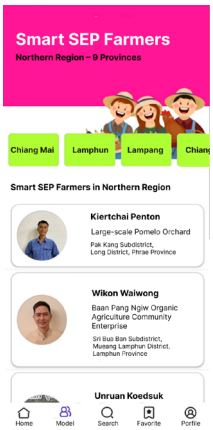

Figure 3. URS-002
(Farmers shall view the list of Smart SEP Farmers in each province.)

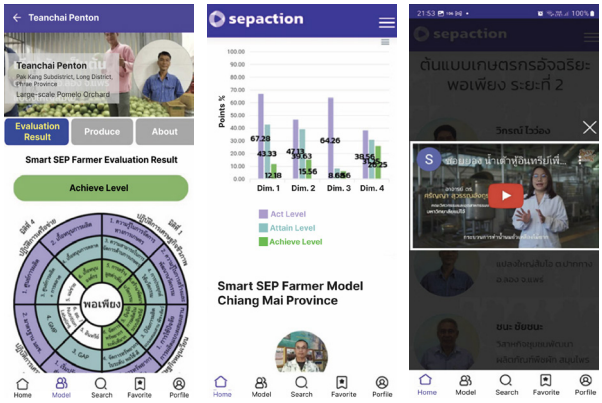

Figure 4. URS-003 and URS-004
(URS-003: Farmers shall view as role model farmer information, their evaluation result, their videos, and their shared works. URS-004: Farmers can view the evaluation results of the Smart SEP Farmers in each province.)

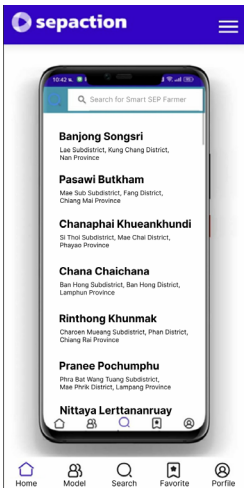

Figure 5. URS-005
(Farmers shall search for the names of Smart SEP Farmers.)

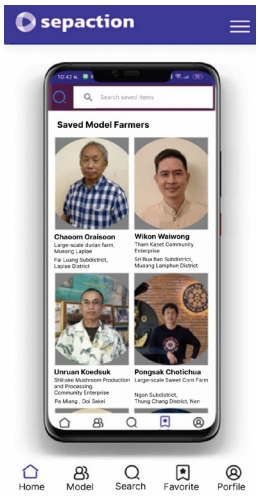

Figure 6. URS-006
(Farmers shall save the names of Smart SEP Farmers.)

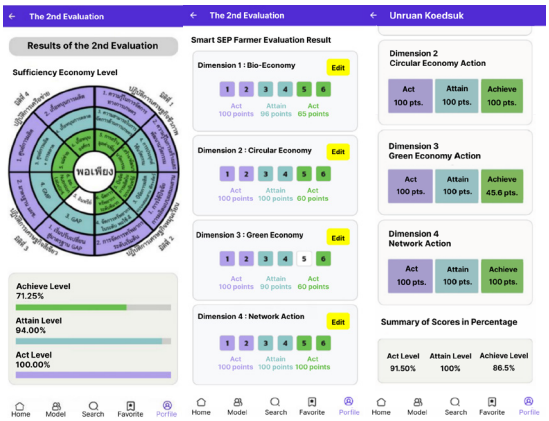

Figure 7. URS-007 and URS-008
[URS-007: Farmers shall assess the Smart SEP Farmers (They can view the evaluation results at the individual or provincial levels. URS-008: Farmers shall see the guidelines for evaluating the operations of farmer groups to move from the Act level (orange circle), Attain level (green circle), and Achieved level. (blue circle).]

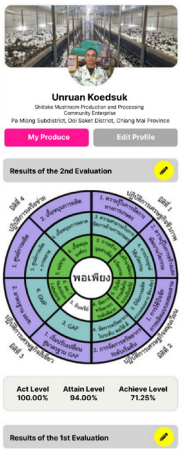

Figure 8. URS-009 and URS-010
(URS-009: Farmers shall edit their information. URS-010: Farmers shall compare the first and second evaluation results.)

For the government sector and academic agencies, the data collection and data analysis from the farmers are visualized, so these two sectors can plan for improving the farmers differently according to the farmers' different needs. We will use website technology in this part because it is better to visualize data on a bigger screen. Thus, the URS of the government sector and academic agencies are as follows;

- ***URS-011*** The government sector and academic agencies shall view the evaluated results of the farmers in each area. (Figure 9)
- ***URS-012*** Government sector and academic agencies shall view the financial results of farmers from each area. (Figure 10)
- ***URS-013*** Government sector and academic agencies shall view the number of farmers in each level separately by the different dimensions of each area, by using the visualization and graph. (Figure 11)
- ***URS-014*** Government sector and academic agencies shall view farmers at each level in each area. (Figure 12)

The user interface (UI) of the smart SEP farmer application is shown as follows;

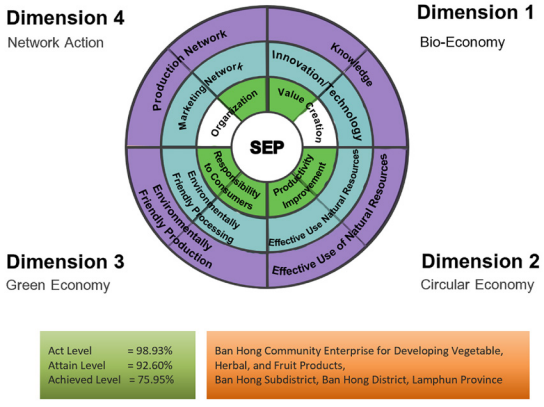

Figure 9. URS-011
(The government sector and academic agencies shall view the evaluated results of the farmers in each area.)

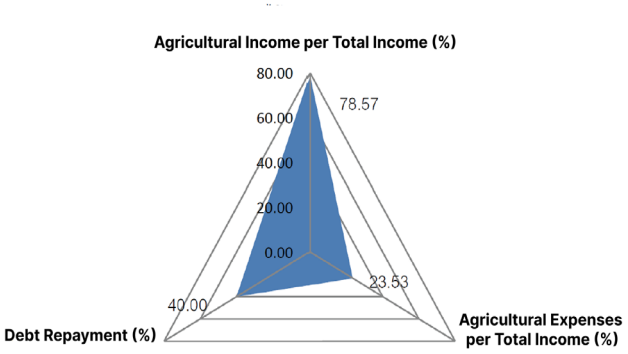

Figure 10. URS-012
(Government sector and academic agencies shall view the financial results of farmers from each area.)

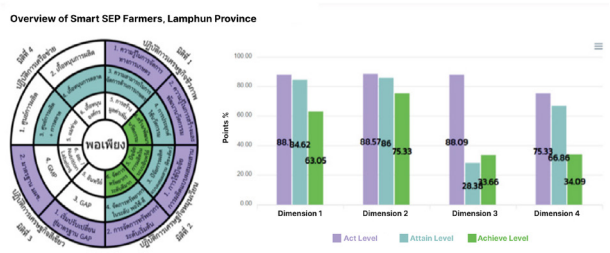

Figure 11. URS-013
(Government sector and academic agencies shall view the number of farmers in each level separately by the different dimensions of each area, by using the visualization and graph.)

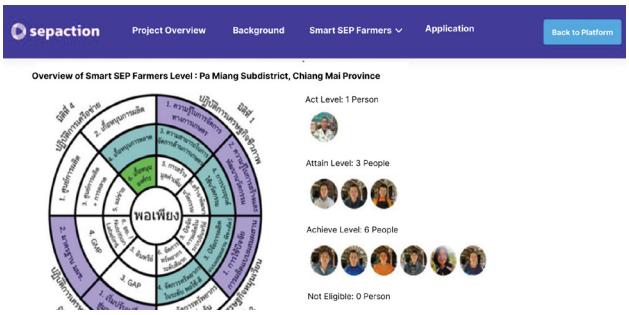

Figure 12. URS-014
(Government sector and academic agencies shall view the farmer of each level in each area.)

2.5 Experimental Scope

To obtain sample groups of farmers to study. The researcher plans to choose 27 farmer groups and select 10 farmers in each group from 1,539 households in 9 upper northern provinces, namely Chiang Mai, Lamphun, Lampang, Chiang Rai, Phrae, Nan, Uttaradit, and Phitsanulok. However, there are 30 groups and 312 farmers required to join the project, as shown in Table 3.

A purposive sampling method was used for this research. The Provincial Agriculture Office selects the outstanding farmers in 4 areas by considering whether 1) The farmers have initiative and efforts to overcome obstacles in creating work. 2) The farmers must successfully work in their careers. 3) The farmers are leaders in various fields, and 4) The farmers conserve

natural resources and the environment. We let each farmer raise their status to be Smart SEP Farmers on the Digital Platform SEPAction and expand the results to all farmers in the sub-districts of the Local Administrative Organizations. The locations of the farmer groups studied were in various sub-districts, under the governance of local administrative organizations. We use the primary data from the survey inquire and interview the context of 30 sample farmer groups and the secondary data from the strategic documents, plans, and agricultural projects of 27 local administrative organizations. The researcher analyzed the reliability of the Smart SEP Farmer assessment questionnaire in all four dimensions by testing it with a pilot test that had similar characteristics to the target sample of the research, which were not farmers in the sample area—tested for confidence (reliability) using the Cronbach Alpha's coefficient method to find the alpha coefficient. The overall test results were obtained at a value of $\alpha = 0.908$, within the acceptable range. There is a correlation value that is not less than 0.2 for every question, which suggests that the Smart SEP Farmer assessment questionnaire is reliable and can be used to conduct surveys among target samples without updating or editing questions.

3 Results

The results of raising the Farmer's Success Level from Act Level to Attain Level and Achieved Level in all nine target provinces from the first and the second assessment are shown in Table 4.

Table 3. Number of farmer groups in the upper northern provinces

Group	Area	Population of farmers (Group)
1	Chiang Mai	300
2	Lamphun	105
3	Lampang	151
4	Chiang Rai	172
5	Phayao	216
6	Prae	150
7	Nan	207
8	Uttaradit	99
9	Phitsanulok	139
Total: 312		1,539

Table 4. Summarizes the Smart SEP Farmer assessment questionnaire results in the upper northern region

Province	Level of sufficiency economy (number of people)								%
	Level 0		Act Level		Attain Level		Achieved Level		
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
Chiang Mai	27	7	7	27	5	5	1	1	137.44
Lamphun	6	0	2	7	11	12	2	2	7.93
Lampang	27	1	0	26	3	3	0	0	29.1
Chiang Rai	40	3	7	37	5	12	0	0	18.66
Phayao	20	1	1	14	10	16	0	0	11.53
Prae	17	0	0	12	5	10	1	1	26.37
Nan	2	0	0	2	42	42	0	0	4.11
Uttaradit	27	5	1	19	12	16	0	0	31.85
Phitsanulok	31	4	0	25	0	2	0	0	14.61
Total: 312	197	21	18	169	93	118	4	4	31.29

It was found that in the first assessment, 197 farmers do not qualify to be the Smart SEP Farmers, 18 farmers are in the Act Level, 93 farmers are in the Attain Level, and four farmers are in the Achieved Level. After these farmers know their strength and weakness according to the results of assessment questionnaire in all four dimensions and join the training events that our related sectors prepared for these farmers, from the second assessment there are only 21 farmers who are not qualify to be the Smart SEP Farmers, 169 farmers who are in the Act Level, 118 farmers who are in the Attain Level, and four farmers who are in the Achieved Level. Their overall increasing potential of the target farmers is 31.29%.

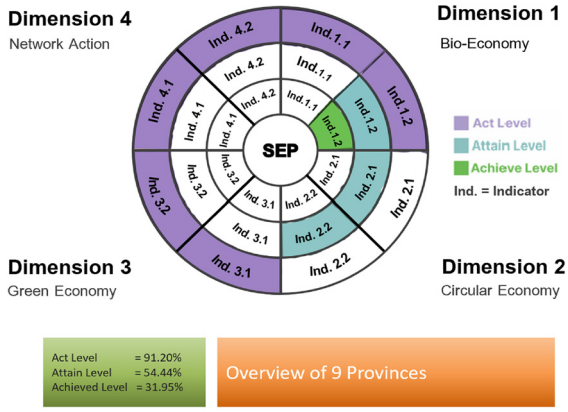

Figure 13. Results from the assessment questionnaire in the overall nine provinces of the upper northern region

From Figure 13, the system visualization shows that after two assessments, farmers' average total points from the assessment questionnaire score in all nine provinces are: 91.20% in the Act level, 54.44% in the Attain level, and 31.95% in the Achieved level. The visualization also shows the pass factors in the four assessment dimensions, and details to evaluate factors in each dimension to let farmers easily understand their strengths and weaknesses.

The proportion of farmers' income, expenses, and debt repayment in all nine provinces is shown in Figure 14. It can reduce expenses in the agricultural sector to only 92,500 baht per year (21.44% of total income), and agrarian debt remains only 102,222 baht annually, or debt can be reduced to 19.74%.

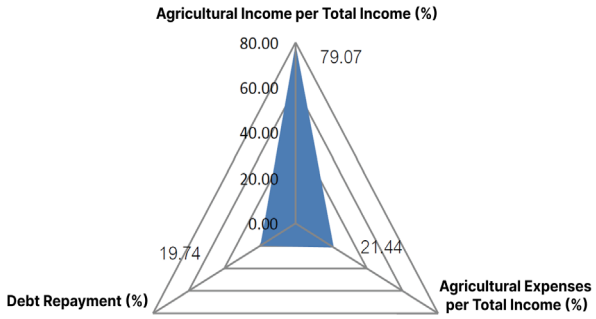

Figure 14. Proportion of farmers' income, expenses, and debt repayment in all nine provinces

4 Conclusions

The research found that developing the potential of farmers to achieve the SEP goal via the smart SEP farmer platform is useful. There is evidence of improvement in various ways: farmers' potential is increased by 31.29%. It also shows that groups of farmers in all nine provinces in the upper northern region's expenses in the agricultural sector are only 21.44% of total income, and agrarian debt can be reduced to 19.74%. The researcher aims to continue the Smart SEP Farmer on Mobile Application project to be used in every region of Thailand to create a national movement to use this innovation to solve the poverty problem of farmers in the country. To ensure sustainability, it is necessary to rely on continuous and regular project evaluation, monitoring, and use.

For the smart SEP farmers' plan in Phase 3, the researchers plan to improve the project in two directions: ***Operational Direction*** and ***Platform Direction***. For the operational directions, we plan to

1) Expand the target farmers to at least 100 farmers per sub-district to get at least 3,000 farmers, and expand using the project operations in all regions of Thailand: Northern, Central, Northeastern, Eastern, and Southern to elevate up to 300,000 farmers to be Smart SEP Farmers. Also, creating agricultural networks with other areas.
2) Let research universities provide agricultural and academic services to the local area. Publicize this research project widely to create awareness. Also, provide training and knowledge in good farm management.
3) Periodic assessment of farmers' agriculture, and let the model farmers be the ones to pass knowledge on to other farmers. Increasing training skills in transferring understanding of various technologies.
4) Add external evaluation features to evaluate farmers from outside agencies, such as setting up a committee to assess farmers who use the application. Or let farmers evaluate each other through the application for verification in the network group. To make the assessment results of agriculture more accurate.
5) Involve government and private sponsors more to raise the level of community products that meet standards. Also, cooperate with the commercial agencies to promote and develop entrepreneurs in health products.
6) Let the government support marketing, to have promoted channels for distributing products to consumers, and to make products well-known. Increase sales and bring exports to the level by connecting access to online marketing technology and expanding the market domestically and abroad to have increased income, decreased expenses, or even increased ability to repay debt.

For the operational directions, we plan to

1) Expanding to cover all mobile application platforms, such as IOS.

2) Adding the notifications feature. For example, the farmer will automatically receive indicator scores when the training is completed. Notification of production factors that help reduce production costs. Notification of market needs information according to each farmer's produce type.
3) Adding buying and selling online features will make farmers self-reliant and sustainable, and it can expand the results to other farmer networks. Promoting markets according to consumer needs to generate income from products and farmer networks. Linked to the futures market system (pre-order) and supporting and promoting the establishment of community enterprise groups.

Acknowledgments

Research on "Driving the Sufficiency Smart Farmer Network with the SEPAction digital platform Towards improving farmers' livelihoods in the upper northern region, Phase 2" has been completed according to the stated objectives and goals. The research team would like to thank the National Research Council of Thailand (NRCT) for funding the research for fiscal year 2023 until it was completed. I would like to thank Prof. Dr. Apichai Panthasen, the research project advisor, and Prof. Dr. Aree Wiboonphong, who have always provided good advice and assistance. All relevant agencies in every sector, including 1) Office of Agricultural Research and Development, Region 1, 2) Office of Agricultural Economics 1, 3) Department of Local Administration, 4) Rice Seed Center, 5) Bank for Agriculture and Agricultural Cooperatives, 6) Center Industrial Promotion Region 1, 7) Public Relations Office, Region 3, 8) Community Development Department, 9) Provincial Commerce Office and 10) Provincial Public Health Office (Public Health Office) that have integrated with researchers from all five institutions; Chiang Mai Rajabhat University, Chiang Mai University, University of Phayao, Maejo University, and Uttaradit Rajabhat University. Thank you to the local government organizations in all nine provinces: Chiang Mai, Lamphun, Lampang, Chiang Rai, Phayao, Phrae, Nan, and Uttaradit. Thanks 27 locations and 312 farmer households in Phitsanulok who have participated in the project throughout the first year to develop the innovative Mobile Application Smart SEP Farmer that can be downloaded and used free on farmers' mobile phones to drive the Sufficiency Smart Farmer Network with the SEPAction digital platform to improve farmers' livelihoods throughout the country. Finally, I would like to thank all team members, including experts who have provided suggestions, improvements, and project research development to make it practical and concrete. Until success and success.

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References

[1] A. Arslan, N. McCarthy, L. Lipper, S. Asfaw, A. Cattaneo, Adoption and intensity of adoption of conservation farming practices in Zambia, *Agriculture, Ecosystems & Environment*, Vol. 187, pp. 72-86, April, 2014. https://doi.org/10.1016/j.agee.2013.08.017

[2] F. Pereira, N. S. Caetano, C. Felgueiras, Increasing energy efficiency with a smart farm—An economic evaluation, *Energy Reports*, Vol. 8, Suppl. 3, pp. 454-461, June, 2022. https://doi.org/10.1016/j.egyr.2022.01.074

[3] S. Wolfert, L. Ge, C. Verdouw, M. J. Bogaardt, Big Data in Smart Farming – A review, *Agricultural Systems*, Vol. 153, pp. 69-80, May, 2017. https://doi.org/10.1016/j.agsy.2017.01.023

[4] A. Walter, R. Finger, R. Huber, N. Buchmann, Opinion: Smart farming is key to developing sustainable agriculture, *National Academy of Sciences*, Vol. 114, No. 24, pp. 6148-6150, June, 2017. https://doi.org/10.1073/pnas.1707462114

[5] R. Abiri, N. Rizan, S. K. Balasundram, A. B. Shahbazi, H. Abdul-Hamid, Application of digital technologies for ensuring agricultural productivity, *Heliyon*, Vol. 9, No. 12, Article No. e22601, November, 2023. https://doi.org/10.1016/j.heliyon.2023.e22601

[6] M. Javaid, A. Haleem, R. P. Singh, R. Suman, Enhancing smart farming through the applications of Agriculture 4.0 technologies, *International Journal of Intelligent Networks*, Vol. 3, pp. 150-164, 2022. https://doi.org/10.1016/j.ijin.2022.09.004

[7] G. Gebresenbet, T. Bosona, D. Patterson, H. Persson, B. Fischer, N. Mandaluniz, G. Chirici, A. Zacepins, V. Komasilovs, T. Pitulac, A. Nasirahmadi, A concept for application of integrated digital technologies to enhance future smart agricultural systems, *Smart Agricultural Technology*, Vol. 5, Article No. 100255, October, 2023. https://doi.org/10.1016/j.atech.2023.100255

[8] E. S. Mohamed, A. Belal, S. K. Abd-Elmabod, M. A. El-Shirbeny, A. Gad, M. B. Zahran, Smart farming for improving agricultural management, *The Egyptian Journal of Remote Sensing and Space Science*, Vol. 24, No. 3, pp. 971-981, December, 2021. https://doi.org/10.1016/j.ejrs.2021.08.007

[9] M. Nikolova, Opportunities and Challenges in the sale of Agricultural Products from Small and Family Farms in Bulgaria, *Trakia Journal of Sciences*, Vol. 18, No. Suppl. 1, pp. 549-559, December, 2020. https://doi.org/10.15547/tjs.2020.s.01.088

[10] M. J. O'Grady, G. M. P. O'Hare, Modelling the smart farm, *Information Processing in Agriculture*, Vol. 4, No. 3, pp. 179-187, September, 2017. https://doi.org/10.1016/j.inpa.2017.05.001

[11] S. A. O'Shaughnessy, M. Kim, S. Lee, Y. Kim, H. Kim, J. Shekailo, Towards smart farming solutions in the U.S. and South Korea: A comparison of the current status, *Geography and Sustainability*, Vol. 2, No. 4, pp. 312-327, December, 2021. https://doi.org/10.1016/j.geosus.2021.12.002

[12] F. Caffaro, E. Cavallo, The Effects of Individual Variables, Farming System Characteristics and Perceived Barriers on Actual Use of Smart Farming Technologies: Evidence from

the Piedmont Region, Northwestern Italy, *Agriculture*, Vol. 9, No. 5, Article No. 111, May, 2019. https://doi.org/10.3390/agriculture9050111

[13] H. Iba, A. Lilavanichakul, Farm Business Model on Smart Farming Technology for Sustainable Farmland in Hilly and Mountainous Areas of Japan, *Land*, Vol. 12, No. 3, Article No. 592, March, 2023. https://doi.org/10.3390/land12030592

[14] J. C. Björklund, Barriers to Sustainable Business Model Innovation in Swedish Agriculture, *Journal of Entrepreneurship, Management and Innovation*, Vol. 14, No. 1, pp. 65-90, February, 2018. https://doi.org/10.7341/20181414

[15] K. Kwanmuang, T. Pongputhinan, A. Jabri, P. Chitchumnung, Small-scale farmers under Thailand's smart farming system, *FFTC Agricultural Policy Platform (FFTC-AP)*, November, 2020. https://ap.fftc.org.tw/article/2647

[16] D. Manapan, *Sufficiency Economy Philosophy*, Royal Thai Embassy in the Czech Republic, July 2021. [Online], Available: https://www.thaiembassy.cz/news-detail.php?id=13&item=1141

[17] A. Pantasen, *Sufficiency Economy: The genius and kindness of His Majesty King Rama IX*, Office of Publishing and Printing - RSU, 2017. [Online]. Available: https://online.anyflip.com/tocrx/skhf/mobile/index.html

[18] The United Nations, *Sustainability Development Goals*. [Online], Available: https://www.un.org/sustainabledevelopment/

[19] National Science and Technology Development Agency (NSTDA), *BCG Concept*. [Online], Available: https://www.bcg.in.th/eng/background/

[20] B. S. Bloom, *Taxonomy of educational objectives: The classification of educational goals*, Addison-Wesley Longman Ltd., 1956.

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