

**A STUDY OF THE MODEL OF SMART FARMING IN URBAN
COMMUNITY**

Eakgalak Kanjananiyom

**A Dissertation Submitted in Partial
Fulfillment of the Requirements for the Degree of
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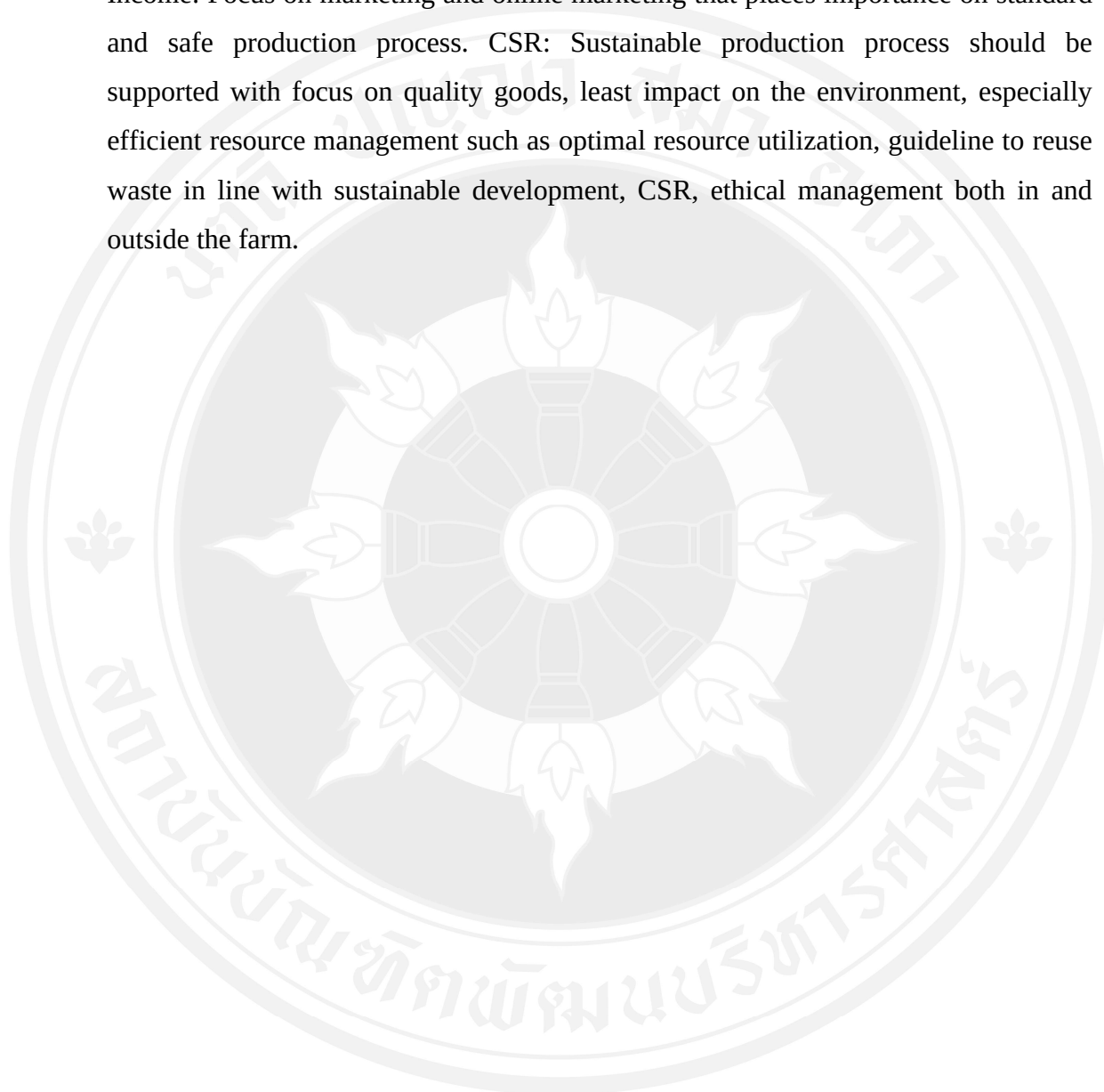
ABSTRACT

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The objectives of this dissertation are 1) to study Smart Farming in urban community including problems and obstacles, 2) to analyze factors affecting the success of Smart Farming in urban community, and 3) to present a model of a sustainable Smart Farming of urban community. This is qualitative study consisted of interviews with experts and relevant agencies on smart farming in urban community: government agencies, state enterprises, public organizations, educational institutes, and private business sector. Smart Farming survey, 10 case studies, selected from farmers who are qualified as Smart Farming according to the criteria of the Ministry of Agriculture and Cooperatives. The data were analyzed for common variables by selecting and extracting duplicate factors for analysis using CIPPI Model and 10 case studies of Smart Farmers to share their opinions and suggestions to create a model and test the model to present a sustainable Smart Farming model of urban agriculture.

The findings reveal that Smart Farming in urban community of 10 case studies of smart farmers consisting of having knowledge on, having marketing about production information to make decisions, having awareness of product quality and consumer safety, having social and environmental responsibility, and having pride in being a farmer. In terms of factors affecting the success of Smart Farming, it consists of commitment and determination, ability to use it devices, ability to plan marketing and online marketing, training attendance for additional knowledge, training attendance for additional knowledge, recording, income-expenditure accounting, sufficiency economy farming, organic farming, and integrated farming, support from the public, business, and private sectors, knowledge of farming from ancestors, output certified with G.A.P. standard and forming of farmer groups for joint farming practice. The model of Sustainable Smart Farming includes for example personnel:

Knowledge and advanced technology of smart farming should be developed, study tours of the smart farming prototype should be organized, as well as online meetings. Planning: Production planning in line with seasons and market demands of customers and consumers, the period where there are a lot of insects and pests must be avoided. Income: Focus on marketing and online marketing that places importance on standard and safe production process. CSR: Sustainable production process should be supported with focus on quality goods, least impact on the environment, especially efficient resource management such as optimal resource utilization, guideline to reuse waste in line with sustainable development, CSR, ethical management both in and outside the farm.



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This dissertation Created by bringing knowledge about smart farming in urban communities in order to take advantage of the research results to be used as lessons. Get to know about Smart Farming in urban communities, problems and obstacles. Factors affecting the success of Smart Farming in the urban community and for the purpose of presenting a sustainable Smart Farming model of urban agriculture for people in the urban community and those who are interested can bring the Smart model. Farming is adapted for farming in urban communities, and Smart Farming can increase productivity in urban communities with limited space.

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CHAPTER 1

INTRODUCTION

1.1 Background and Significance of the Study

Thailand has a total population of 66,090,475 people from the population data from the 2022 (Registration Technology Development and Administration Division, Bureau of Registration Administration, Department of Provincial Administration, National Statistical Office). A large number of population lived in cities with density as Concentrate of Population. It was a big gathering in a particular point that impacted the quality of life of the population living around urban community, which included shortage of resources, polluted environment, economic and social problems, higher land prices so that those in need of housing could no longer build their house or residence in cities. They would need to seek housing in suburban areas with less dense population and lower land prices than in urban areas. Suburban areas were generally surrounded by agricultural areas so that urban areas were not connected because agricultural areas were hidden in between in small plots. Agricultural areas were changed into residential areas. As time passed, the problem increased every day. Suburban areas were then turned into urban community as Urban Sprawl (Palin Vuthichartvanich, 2015). Subsequently, the population living in the area did not have efficient access to public health, public utilities, and the government's transport.

As the agricultural land was hidden in urban community or as urban community encroached upon agricultural areas or green areas, many problems and impacts arose. For farmers who used to work and live on the land, their land might be bought up or they might be driven from the land as tenants and not land owners. So, the farmers ended up having no land to work for their livelihood. They faced the following problems: environmental problems, land degradation, farmers' lack of knowledge and understanding of the changes of social structure, marketing, production of goods in response to the demand of consumers, and labor shortage

(Ruthaichanok Jingjit, 2016). For example, the research of the guideline to increase income of rice farmers at Ban San Nong Khwai, Doi Ngam Subdistrict, Phan District, Chiang Rai discussed the increase of income of rice farmers. The farmers wanted supplementary occupation apart from rice cultivation, and sought funding and market to accommodate their occupation. They lacked knowledge on market and needed funding in development. All farmers were in debt as income from agricultural products and wage was not sufficient (Kwunporn Sutha, 2017). They had limitations in using technology to increase yield, reduce costs and working time, as well as development of potential for competition. Moreover, air pollution, wastewater from increased number of households, public utilities for wastewater treatment or drainage which were not compatible and sufficient against the increased number of households and population impacted eco system, causing foul smell and harmful to life, people's and pets' health. Public aqueduct could no longer serve agriculture. It caused serious destruction of the environment, harmful to livelihood, or no longer appropriate for farming.

As for management that could solve sustainable problems, environmental problems must be the first priority to be solved. Fresh air, pure water, rich soil for cultivation in all seasons would increase farmers' income. The user-friendly IT where all have easy access, at affordable prices would increase yield, reduce costs, leading to competitiveness both at domestic and international levels. Focus should be on reduction of toxic chemicals, harmful to humans and environment. The problem of labor shortage in the agricultural sector must be addressed with the government's stimulus packages including taxes or grants that would enable farmers to live on their own.

As many plots of agricultural land, both big and small, were hidden in urban community, most farmers generally used the same, earn a living old management. They used fixed pattern of work, including cultivation or husbandry, without using and applying new knowledge and technology in line with the land size and production volume. Consequently, the yield was not worthwhile with high costs. The farmers could not compete with large entrepreneurs with more capital and production factors. They did not have knowledge and understanding to reduce labor force, time, and working process while increasing yields more effectively and efficiently (Brandinside,

2016). Such knowledge and understanding would enable farmers themselves to have more time to focus on environmental quality in response to the demand of consumers with requirements of safe, hygienic food from truly pollution-free, environmental-friendly farms. The farmers would need to improve, change, and develop themselves by upgrading quality of work towards the modern Smart Farmers with the application of technology for sustainable and secure occupation in the future, and by applying their own knowledge and wisdom, as well as accumulated skills and expertise, in accordance with the context of their occupation.

The concept of Smart Farmer is part of the objective of the one in four strategies from Agricultural Development Plan by Office of the National Economic and Social Development Board, which was in accordance with the 12th National Economic and Social Development Plan. This concept adheres to Sufficiency Economy Philosophy, sustainable development, people-centric development, economic growth that reduces inequality and drives growth from increased productivity on the basis of the use of wisdom and innovation. Moreover, the goal and objective are formulated to enable farmers to use knowledge and ability for compatible production planning and marketing, that is, production that meets the demand of market. Once in the market, the yields can compete with other farmers both for quality and prices. To meet the demand of consumers, the farmers must upgrade themselves with readiness to move towards professional farm managers with sustainable success (Office of the National Economic and Social Development Council, 2017). With the current social situations, consumers place importance and pay attention to the quality of food that they consume at each meal. They all demand high quality agricultural products which are safe for consumers, and environmental-friendly in every production process. But the problem lies with the farmers themselves, the farmers still lack knowledge, understanding, in-depth information on marketing for production planning to acquire the yield that fits the demand with no oversupply of products in the market, resulting in plunging prices and requiring the government's policy to support them. This kind of situation takes place every year when the prices of the farmers' yield plunges due to oversupply. Therefore, the concept of Smart Farmer is a crucial mechanism to sustainably solve the problem. The farmers also need to develop themselves to acquire knowledge and understanding

in management that can apply advanced technology to old wisdom to develop their yield with quality, reduce costs, labor force, chemicals, and place importance on production standards to produce high quality agricultural products to consumers' satisfaction.

Thailand's climate facilitates cultivation and husbandry. The diverse geographical areas also facilitate cultivation of diverse economic crops, including rice, tapioca, rubber, corn, sugarcane, and various fruits such as longans, durians, rambutans, pineapples, generating income of billions of baht a year to farmers. However, agriculture in Thailand still faces many problems. In particular, the productivity is not high and the farmers' average income is relatively low. The main reasons are that farmers lack sufficient knowledge, in-depth market information for production planning, as well as lack of knowledge in producing high quality goods that are safe for consumers and environmental-friendly. The problems reflect the fact that farmers' profession in Thailand still lacks sustainable development. Farmers are still unable to make farming a source of secure income. Although the net income of farmers' households increases, the prices of production factors and costs of living increase as well. Moreover, the prices of yield also fluctuate, resulting in farmers' increased debt (Ruthaichanok Jingjit, 2016).

Successful Smart Farmer requires knowledge in technology, electronics, computer, and IT and applies the knowledge in their agricultural practice in parallel with existing wisdom, knowledge, and expertise for maximum benefit in order to produce high quality agricultural products. The agricultural development must be in accordance with four dimensions namely reduced costs, increased production quality and product standards, reduced risks from pests and natural disasters, and management and knowledge transfer (Ruthaichanok Jingjit, 2016).

The government's major measure is the establishment of the National Agricultural Big Data Center (War Room) to link information from all sectors and formulate development plan at the provincial level for agricultural zoning and disseminate the information to farmers so that the concept of Smart Farmer may materialize and the government must be prepared to work alongside farmers. Smart Office is developed with academic knowledge and policy that can apply technology and policy to efficiently support farmers. If the concept of Smart Farmer succeeds

and reaches the objective, it will benefit upstream work of Ministry of Agriculture and Cooperatives and the downstream work of Ministry of Commerce for agricultural products, especially the reduction of costs and the increase of production standards. They will ease the burden of Ministry of Commerce who is in charge of agricultural products subject to regular fluctuations and has less need to implement the policy to support prices of agricultural products and encourage market mechanism to work by itself more (Ruthaichanok Jingjit, 2016). Moreover, it will constitute to easy marketing of agricultural goods, especially positioning of agricultural products in the competition of upper market to reach the goal of increased trade value.

The most important sensitivity and fragility that cause the development of farmers to lack sustainability partly relate to the government's policy designed to assist farmers but it is not on the concept of sustainable development for farmers in their profession. It should start with the development of farmers themselves, especially strengthening farmers to depend on themselves in the long term so that the government does not need to formulate policy to solve immediate problems and support farmers all the time. Therefore, the concept of Smart Farmer is a major mechanism to respond to the development and it is expected to transform Thailand's agriculture in the future.

The BCG model, derived from the Thailand 4.0 economic development approach, aims to transform Thailand's economy through three interconnected dimensions: Bio Economy, Circular Economy, and Green Economy. biodiversity and cultural diversity in the four main industries: food and agriculture; health and medical industry, energy, materials and biochemical. and tourism and creative economy. The model emphasizes smart farming as a key driver. It aims to shift from traditional farming to a technology-driven, precision approach. Thailand strives to increase agricultural productivity, reduce waste, improve value chains. and creating social and environmental sustainability through the use of innovation and technology. Ultimately, BCG intends to drive Thailand beyond the middle-income trap. promote inclusive growth higher income distribution and environmental protection This is in line with the United Nations Sustainable Development Goals.

The BCG model, built on Thailand 4.0, focuses on three economic dimensions: bio-economy, circular economy and green economy. This is rooted in the

country's strengths in biodiversity and cultural diversity. The strategy targets four key sectors: food and agriculture; health and medical industry energy and biochemistry and tourism and creative economy. The core of BCG lies in Smart Farming, which will drive Thailand's economy towards sustainable development by leveraging technology and innovation to increase productivity and value in the agricultural sector. The model's approach to change seeks to shift Thailand's economic paradigm from "More effort Less Profits" to "More Returns with Less Effort" ushering in a new era of growth, efficiency, and shared prosperity.

The BCG model, derived from Thailand's 4.0 economic development guidelines, aims to transform the Thai economy through three interconnected dimensions: Bioeconomy, Circular Economy, and Green Economy. These dimensions are rooted in the country's strengths in biodiversity and cultural diversity. The strategy focuses on four key industries: food and agriculture, health and medical industry, energy and biochemistry, and tourism and creative economy. At the heart of the BCG model is smart farming, committed to transforming traditional farming into a precise, technology-driven approach. This approach aims to increase agricultural production, reduce waste, improve the value chain, and promote social and environmental sustainability through innovation and technology.

The ultimate goal of the BCG model is to propel Thailand beyond the middle-income trap, promoting inclusive growth, higher income distribution, and environmental protection. This aligns with the United Nations' Sustainable Development Goals and represents a shift from the paradigm of 'More effort, Less Profits' to 'More Returns with Less Effort,' ushering in a new era of growth, efficiency, and shared prosperity for Thailand. (The Office of National Higher Education Science Research and Innovation Policy Council [NXPO], 2021)

The study of Smart Farming in urban community will mainly focus on the study of Smart Farming in urban areas. Farmers who meet the Smart Farming criteria set by (Ministry of Agriculture and Cooperatives, 2013) will be selected using the Smart Farming framework concept. The intended outcomes of this study include benefiting farmers and individuals interested in Smart Farming within urban area as well as generate new insights into practical models for the implementation of Smart Farming in urban community. It is expected that the research results will facilitate

efficient use of results by relevant agencies to promote Smart Farming in urban community.

1.2 Research Questions

1.2.1 How is the situation of Smart Farmer agriculture in urban community? What are the problems, obstacles, and successes?

1.2.2 What are the key success factors of Smart Farmer agricultural practice in urban community?

1.2.3 What should be the sustainable Smart Farming model in urban community?

1.3 Objectives

1.3.1 Study Smart Farmer agricultural practice in urban community including the study of problems and obstacles.

1.3.2 Analyze the key success factors of Smart Farmer agricultural practice in urban community

1.3.3 Recommend sustainable Smart Farming model for agriculture in urban community

1.4 Scope of Study

This research conducted the study on Smart Farming in order to use the study results as a model of Smart Farming in urban community.

1.4.1 Scope of the content to study the process of Smart Farmer agricultural practice and study the key success factors of Smart Farmer agricultural practice. The content of the study consisted of three parts as follows:

Part 1 Interview Experts and Relevant agencies government and private sector.

Part 2 Survey of 10 farm areas as case studies selected according to Smart Farming criteria.

Part 3 Test Model: Based on the presentation of the model of sustainable Smart Farming for farmers in urban community through the online meeting with the Smart Farming entrepreneurs of the 10 case studies using the conceptual framework of the model of Smart Farming.

Select the farms under the criteria of Smart Farming as pilot farm for the study.

1.4.2 Scope of population and study of ten areas of employees in model farms as follows:

1.4.2.1 Hydroponics Vegetable Farm Ampawa Sub-District Ampawa District Samutsongkhram Province

1.4.2.2 Uncle Daeng's Melon & Salad Farm Khlong 7 Sub-District Khlongluang District PathumThani Province

1.4.2.3 Suanlungthod, 43 Moo 5, Nong Sam Wang Subdistrict, Nong Suea District, Pathum Thani Province

1.4.2.4 Suanpanisara, 99/1 Moo 8, Nong Khai Subdistrict, Krathum Baen District, Samut Sakhon Province

1.4.2.5 Pitak Mushroom Farm, 45 Moo 5, Tha Khai Subdistrict, Mueang Chachoengsao District, Chachoengsao Province

1.4.2.6 Lertphol Riceberry 26bMoo1 Mahasawad Subdistrict Bhuddamonthon District, NakhonPhathom Province

1.4.2.7 Pomelo Orchard Sampran 9/1 Moo 4, Bang Toei Subdistrict, Sampran District, Nakhon Pathom

1.4.2.8 Palmyra Palm Phetchaburi 21 Moo 2, Tham Rong Subdistrict, Ban Lat District, Phetchaburi 7610

1.4.2.9 Pin-Chai Date Orchard 13/1 Moo 3, Nang Kaeo Subdistrict, Photharam District, Ratchaburi

1.4.2.10 Bangkachao Farm 21 Moo 2, Soi Phetcha Hueng 21/1, Bang Yo Subdistrict, Phra Pradaeng District, Samut Prakan

1.4.3 Scope of timeframe for collection of information between June 2021-December 2022

1.5 Expected Benefits

1.5.1 Acquire knowledge on Smart Farmer agricultural practice in urban community, problems and obstacles

1.5.2 Acquire the key success factors of Smart Farmer agricultural practice in urban community

1.5.3 Serve as the guideline to recommend the sustainable Smart Farmer model for agriculture in urban community

1.5.4 Urban residents who are interested can apply the Smart Farming model to urban community, Government agencies can issue measure for drive smart farming in urban community and Private sector can establish Smart Farming learning center for Urban Community.

1.5.5 Smart farming supports sustainable management of natural resources and contributes to improving environmental quality in urban community.

1.6 Definition

Smart Farming means intelligent farming by using technology to manage cultivation system in every process and can control everything with technology to inspect, collect information, analyze, and solve the problems of cultivation based on Real-Time, as well as showing the results of the growth and expected output with precision. In fact, Thailand is still at the initial stage because Smart Farming requires personnel with expertise and support from many sectors. The farmer must also learn and develop oneself and ready to shift from the old method.

Urban Community is the community in the urban area with diversities in profession, lifestyle of the population, progress in communication, transport, market, shops, government buildings, and some people still practice agricultural profession.

This research took interest in the study of farms situated in subdistrict municipalities and urban communities with the population of over 7,000 and densely populated at the average not fewer than 1,500 people per km as certified by Ministry of Agriculture and Cooperatives on the Smart Farming standard or in the process of

request for certification or trend to submit the request for certification of the Smart Farming standard.



CHAPTER 2

LITERATURE REVIEW

For the study of Smart Farmer agricultural practice in urban community towards Circular Economy, the researcher studied the relevant concept, theory, and research as follows:

- 1) Concept and theory of Smart Farmer
- 2) Concept and theory of Knowledge Management
- 3) Concept and theory of Farmers' learning
- 4) Concept and theory of relevant policies and strategies
- 5) Concept and theory of Circular Economy
- 6) Concept and theory of the Urban Community
- 7) Concept and theory of CIPPI Model
- 8) Smart Farmer abroad
- 9) Relevant research works

2.1 Concept and Theory of Smart Farmer

The main concept of Smart Farm is the use of electronics and computer technology, as well as information and communication technology to develop the entire supply chain of agricultural products to upgrade output, product standards, and reduce costs. The agricultural development is in four dimensions as follows: 1) Reduce costs 2) Increase production quality and product standards 3) Reduce risks from pests and natural disasters and 4) Management and knowledge transfer. The concept of Smart Farmer, in the Ministry of Agriculture and Cooperatives' view, means farmer with in-depth knowledge in agricultural profession, ability to plan by knowing demand, market, and preparation for production for compatibility, as well as ability to increase production efficiency and solve problems with speed, the analysis of well-rounded information as element in decision-making based on the principle, as

well as application of agricultural technology. On the dimension of output of Smart Farmer, it will focus on environmental-friendly production of agricultural products with high quality, and safety for consumers. On income towards Smart Farmer, farmers will have income at least at the same level or more of minimum wage. All these qualifications will promote farmers to become Smart Farmer that is self-reliant on a sustainable basis (Ministry of Agriculture and Cooperatives, 2022).

Smart farm is innovation derived from the royal initiative of H.M. the Late King Bhumibol Adulyadej (Father of Thai Innovation) to promote, support more farmers and entrepreneurs to use agricultural innovation, leading to increased productivity and sustainable development of agricultural sector in the future.

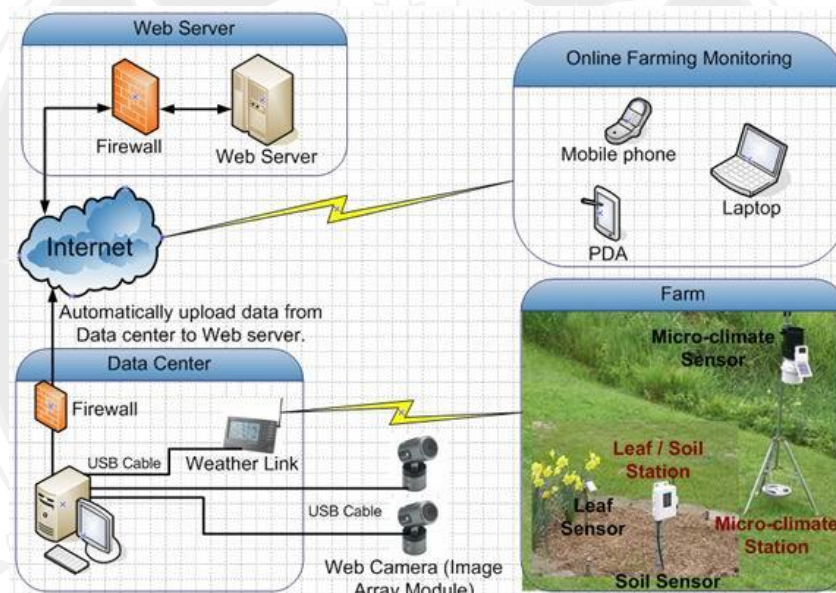


Figure 2.1 Smart Farm

Source: Smart Farm (Thailand) (2015).

Smart Farm is a form of modern agricultural practice which will enable farming to have immunity against climate change. The information of climate at the level of Microclimate, Mesoclimate, and Macroclimate is used in management and care of the cultivated land in line with the climate, as well as readiness to cope with climate change in the future. It is named Precision Agriculture and is widely used in

US, and Australia. It starts to be popular in many European countries, Japan, Malaysia, and India (Smart Farm (Thailand), 2015).

The main concept of Smart Farm is the application of electronics and computer technology, as well as information and communication technology in the development of supply chain of the production process of agricultural products to consumers to upgrade production quality, reduce costs, and develop product standards. Smart Farm is an attempt to upgrade agricultural development in four main dimensions namely 1) Reduced costs in production process 2) Increased quality of production standards and product standards 3) Reduced risks in agricultural sector derived from the outbreak of pests and natural disasters 4) Management and knowledge transfer by applying IT from research to practical development and focusing on the use of IT for farmers. The technologies used in Smart Farm (Office of Small and Medium Enterprise Promotion [OSMEP], 2018) are as follows:

- 1) Global Positioning System (GPS) is technology to identify the coordinate or position on earth by using 24 satellites that move around the globe in 6 orbits at the height of 20,200 kms above the earth.

- 2) Geographic Information System (GIS) is technology that compiles and analyzes area-based information that demonstrates the result in various forms. Information can be collected in many dimensions. The well-known GIS is Google Earth.

- 3) Remote Sensing is technology of long-distance perception. It is the tool to collect area-based information by using light wave in various wavelengths and electromagnetic radiation such as radar, microwave, radio, etc. These sensing tools are generally installed on aircrafts or satellites.

- 4) Proximal Sensing or technology of long-distance perception by using various sensors directly in the point of interest such as Weather Station, Soil Sensor, Plant Disease Sensor, Yield Monitoring Sensor, etc. These sensors can be set into Wireless Sensor Network by installing in farmland to collect information such as humidity in soil, volume of light, and chemicals.

- 5) Variable Rate Technology (VRT) or technology to give fertilizer, waste, pesticide according to different areas. It is generally used with GPS technology.

6) Crop Models and Decision Support System (DSS) is technology that integrates all mentioned technologies to use in the decision of what to do with a farm, when, how, as well as forecast of yield.

Smart farming in Thailand may face some limitations. Some technology system is not efficient such as GPS and GIS and requires high investment. Farmers still lack expertise in the use of the equipment. The world is moving to physical and social changes, as well as knowledge, information, news with rapid exchanges in all regions. Thai farmers need to change themselves according to their livelihood, opening up of learning, information, and news to move towards Smart farmer based on the practical guideline of Ministry of Agriculture and Cooperatives. The basic qualifications of Smart farmer consist of six dimensions as follows: (Smart Farm (Thailand), 2015)

Dimension 1: Must be knowledgeable person in the topic that one is involved, and can transfer agricultural technology or provide advice to other interested persons in the topic that one is involved.

Dimension 2: Information accompanying decision-making. Can gain access to information from government officials and through other information and communication technologies such as Internet, Mobile smart phone, etc.

Dimension 3: Management of yield and marketing. Ability to manage production factors, labor force, and capital. Can connect production and marketing to sell output. Ability to manage residues from efficient production (Zero waste management).

Dimension 4: Aware of product quality and safety of consumers. Knowledgeable or trained on the standards of GAP/GMP, organic agriculture, or other standards.

Dimension 5: CSR, production process that does not generate pollution and is environmental-friendly (Green economy), continuous activities to assist community and society.

Dimension 6: Proud to be farmer. Committed to agricultural profession. Love and cherish agricultural land and profession for the next generation. Happy and satisfied in agricultural profession. (Smart Farm (Thailand), 2015)

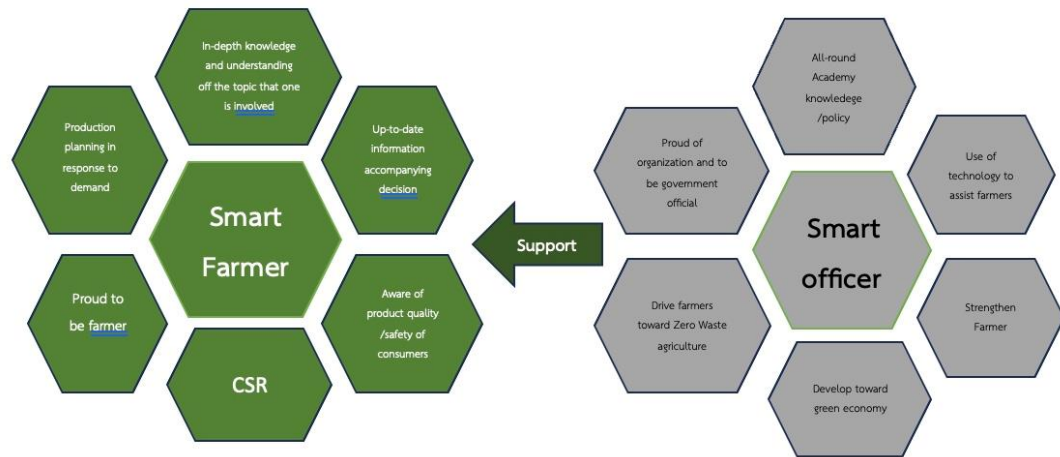


Figure 2.2 Basic Qualifications of Smart Farmer

Source: Smart Farm (Thailand) (2015).

The process to create Smart farmer is to develop Smart Officer or government official with academic knowledge and policy to apply technology to support farmers by guiding farmers according to environmental-friendly development. As for moving towards Smart Officer, work process is improved starting from in-depth understanding of the type and volume of agricultural yields of each area, as well as problems of each yield and must connect with research centers of agency networks in Ministry of Agriculture and Cooperatives, and information from Office of Agricultural Economics to efficiently plan production for farmers. Apart from development of farmers to become Smart farmer with Smart Officer as close friend, the country's agricultural sector is transformed based on the concept to drive the development meaning Zoning = Area + Commodity + Human Resource. The main context is to drive the policy of management of agricultural Zoning in one area to succeed. It requires readiness of three main factors namely appropriate management of area and resources (Area), production of goods in response to the demand of market (Commodity), as well as personnel responsible for agriculture both farmer and government official (Human: Smart Farmer & Smart Officer) who will manage agricultural production and efficient Value chain.

Smart Farm is modern technology in accordance with Sufficiency Economy due to similar principles namely optimal use of resources and maximum benefit. Therefore, Smart Farm is yet another interesting innovation to drive agriculture with more potential, leading to the development of the country's agricultural system for future sustainability (Ruthaichanok Jingjit, 2016).

Obstacles and Difficulties in Smart Farming

The factors that hinder Thai farmers from completely using technology are numerous with complex problems. The problems can be divided into the following:

1) Investment in innovation causing difficulty in gaining access to the downstream. Many times, we understand that innovation will make quality of life better. That means looking at the downstream of the use of innovation. But looking more in detail, for general people to use innovation, it is necessary to invest in the process to create environment to efficiently use innovation. For example, if we want water system to be automatic to control waste in our farm through smart phone, the problem is that most farms of Thai farmers use home electric lighting which cannot sufficiently respond to the consumption of electricity. It is necessary to hire engineers to design new electric system for industrial system, losing a lot of time and money until the water system can really function. Many more things are necessary for planning such as irrigation system, farm planning, piping system, etc. which require diverse fields of knowledge to design and construct these systems.

2) Not compatible with the old pattern in adapting the farm system into Smart Farming, we generally imagine that everything will be system with clear information, with advanced technology, detailed and complete information back to farmers. But many times, information or system of the functioning is advanced or too difficult for general people to be actually practical which will cause Smart Farm to fail. Because despite sufficiently good innovation, users find it complicated to learn to use it. At the same time, technology is too advanced and complicated so that those with no former background can understand. Therefore, the design of Smart Farming system requires former habit of actual user so that the learning is not too complicated.

3) Innovation is created by many people: As the procedure and process of agriculture are diverse, and technology producers themselves may not have expertise in all aspects of agriculture, each process of cultivation needs to use

technology of many producers. The problem is that each producer has different standards so linkage is difficult and may cause inefficient functioning.

4) Unclear cost-benefit investment: Generally, small farmers mainly earn their living in agriculture and have charges in their lives. If they need to invest in the Smart Farming system with high initial costs and high hidden costs, small farmers may not be able to actually use technology because they cannot invest in the technology.

At present, Thailand starts to use more technology in Smart Farm but only in small groups and not widespread due to many problems, including costs, import of tools and equipment, and unclear cost-benefit in production. But if technology can be developed, costs will go down and Smart Farming may be widely practiced in the future without too much difficulty. If the costs of technology go down sufficiently, and if Thai farmers are supported for the transformation to use widespread Smart Farming system, Thailand can control the quality of yield as required, including sweetness, size, color, and can grow anything on this earth, with will greatly increase value for Thai farmers. (Agricultural Research Development Agency Public Organization [ARDA], 2021)

Characteristics of Farmer (Office of the Permanent Secretary for Ministry of Agriculture and Cooperatives [OPSMOAC], 2013)

General farmers in the country are developed into Smart Farmers with the required characteristics as follows:

- 1) Readiness, in possession of knowledge and expertise in agricultural profession in the value chain of agriculture in accordance with way of life and nature of operation of each individual
- 2) Importance given to knowledge and information accompanying decision-making
- 3) Use or development of technology, wisdom, and best practice
- 4) Awareness of quality, standards, and market demand
- 5) Awareness of consumers' safety and environment
- 6) Be environmentally and socially responsible
- 7) Have a passion for being a farmer.

2.1.1 Concepts and Theories on Smart Farming

The policies of Ministry of Agriculture and Cooperatives on the development and the creation of farmers towards Smart Farming constitute the cooperation among major ministries namely Ministry of Interior, Ministry of Agriculture and Cooperatives, Ministry of Natural Resources and Environment, and Ministry of Information and Communication Technology to integrate work in order to develop and upgrade the production of agricultural products, increase value and prices of agricultural products and food, including the proper and appropriate arrangement for the agricultural areas and forests, upgrading farmers' quality of life under the policy of Ministry of Agriculture and Cooperatives to transform Thai farmers into Smart Farmers with Smart Officer as coach to develop farmers towards Smart Farmers and to strengthen them for sustainable self-reliance. The pilot farmers in each field lack learning sources to serve as knowledge network and assistance to local farmers, both for those who met the qualifications and still required additional agricultural techniques and for those who did not meet the qualifications under the particular item. The survey and assessment of the farmers' qualifications according to the Smart Farmer policy had the major objectives of Smart Farming as follows: (1) Develop farmers who met the assessment of the qualifications in terms of income and the basic qualifications towards the pilot Smart Farmer in each field (2) Create learning source of pilot smart farmers to strengthen the farmers for sustainable self-reliance, better quality of life, job security, and (3) Enable officials relevant to agriculture to have knowledge, and understanding of the agricultural Zoning, Smart Officer for safe production of agricultural products according to the ASEAN GAP standard in order to be prepared to enter the ASEAN Economic Community (Smart Farm (Thailand), 2015).

The three major components of Smart Farming (Smart Farm (Thailand), 2015) included the following: (1) Identify the appropriate area for cultivation by using GIS (2) Interpretation and data analysis of appropriate sensor to be in line with the duration of plant cultivation that fluctuated according to the weather and (3) Area management using appropriate technology to reduce resources and respond to the congruence of plant cultivation which for Smart Farming involved precision leading to the plant cultivation that was congruent with the area through decision-making

based on correct information. The examples included (1) Control of precision watering to ensure correctness in terms of quantity, duration, and control via advanced tools such as smartphone and computer (2) Use of sensor in the monitoring process and control process through temperature, humidity, air, and humidity in the soil to facilitate the release of water from the nozzle to adapt temperature in the farm and control of watering for plants and (3) Use of EC sensor for fertilizer in the water for hydroponics plant cultivation to ensure the application of fertilizer with precision through the plant watering system such as cultivation of salads to reduce production costs, increase output per area, create production standard, control of output quality as customer demand, and prices of output were higher than general farms. The data from weather and soil stations at different installed spots in the farm will be collected and sent wireless to computer in the farm owner's house, with the ability to follow the data as real time via many channels, including data display program in the central computer in the field or data watched on the internet via website. So, farm owners can manage their own farm all the time wherever they are, using either computer, tablet, or smart phone.



Figure 2.3 Weather Station and Soil Station

Source: Smart Farm (Thailand) (2015).

Functioning of Smart Farmer

In the work of Smart Farmer (Maejo University, 2022), the smart farm system collects data, micro-climate and meso-climate data from Wireless Sensor Networks installed at various points within the farm by collecting the following data.

1) Temperature Sensor is the sensor that changes the temperature into electrical signal and the electrical signal is in the form of Voltage or Resistance. For example, Thermocouple (TC) changes the temperature into Electromotive Force (EMF) and Resistance Temperature Detector (RTD) changes the temperature into Resistance.

2) Humidity Sensor is the equipment to measure Relative Humidity (RH) which means (volume of actual vapor in the atmosphere per/volume of vapor that causes saturated air) x 100 at the same temperature of (actual vapor pressure per/saturated vapor pressure) x100 as shown in % with the unit of %RH.

3) Optical Sensor is the electronic equipment that changes the resistance or electrical conductivity through itself with the incident light.

4) Weather Station measures and inspects weather conditions through various tools. Then, data processing based on the statistical principles, resulting in weather forecast. Basically, a weather station has sensors consisting of Rain gauge to measure rainwater with the unit of millimeter, Anemometer measure wind speed with the unit of kilometer/hour, Weathervane to measure the direction in which the wind blows with the unit of degree.

5) Macroclimate meteorological data (radar, satellites, weather model). Satellite is a human invention that orbits the earth relying on the earth gravity, resulting in the ability to orbit the earth similarly to the moon that orbits the earth and the earth that orbits the sun. The objectives of this invention are numerous: military purposes, communication, weather report, scientific research such as geological survey, observations of space, the earth, the sun, the moon, other planets, as well as observations of objects, stars, and galaxies.

All data is stored on the internet in the form of database. It is presented to the farmer, the farm owner via website to accompany decision-making and plan cultivation in terms of water, fertilizers, and pesticides, etc.

At present, the data can be stored in the cloud system. For example, Firebase is the system that can store data from sensor in the form of Real-time Database. The stored data is NoSQL cloud database or in the form of JSON. The data is improved regularly (real-time synchronization) with all devices which are automatically connected by accommodating work when the devices are not connected with the database (offline). When all data is disconnected with the database, the data will be stored in the devices (local) until the devices are connected with the database (online). The devices will automatically update the data by which Firebase will accommodate the operating system both Android iOS and Web.

2.1.1 Application of Technology with Smart Farmer Practice

Agriculture in Thailand still faces many problems especially in the dimension of Productivity which is low and the farmers' income on the average is low as well. Farmers do not have sufficient knowledge, lack in-depth information of marketing for production planning, as well as knowledge of production of high quality products that are safe for consumers and environmental-friendly. The problems reflect the fact that the farmers' profession still lacks sustainable development especially strengthen them for long-term self-reliance, so that there is no need for the government to formulate the policy to solve urgent problem and support farmers. The concept of "Smart Farmer" is therefore an important mechanism to respond to the development by using electronic and computer technology, and information technology in the development of agricultural products in the supply chain to upgrade productivity, product standards, and reduce costs. The agricultural development consists of the following four dimensions (1) Reduced costs (2) Increased production quality and product standards (3) Reduced risks from pests and natural disasters and (4) Management and knowledge transfer. (Database of promotion and upgrading of OTOP products, 2021)

In order to have in-depth knowledge on agricultural profession, farmers can plan by taking into account the demand of market and preparing production accordingly, as well as ability to increase production efficiency and solve problems quickly. The analysis of all-round data is the element for decision-making which is based on principle and reason, as well as knowledge of the application of technology in agriculture. The guideline of sustainable agricultural development is to solve the

problem at the root by upgrading production efficiency or increasing Productivity from application of technology through the development method that focuses on farmers so that they can efficiently apply scientific knowledge and agricultural technology and in line with the demand of each area especially assistance farmers to gain access to IT, production technology, and management system.

Smart Farmer will link with the management of agricultural database. There will be a project to link agricultural network from raw material in the production of agricultural yield, to market focusing on sales of organic agricultural products. As for the management of alternative energy in the agricultural farm, residues will be used as alternative energy such as biogas reactor is used to reduce wastefulness. Water is most economically and appropriately managed in agricultural plots. Agricultural farm is also designed to prevent loss in agricultural investment. ((Database of Promotion and Upgrading of OTOP Products, 2021)

The concepts and theories on Smart Farming drive the policy of Ministry of Agriculture and Cooperatives to develop and create a farmer into Smart Farmer which is the cooperation among 4 major ministries namely Ministry of Interior, Ministry of Agriculture and Cooperatives, Ministry of Natural Resources and Environment, and Ministry of Information and Communication Technology who perform integrated tasks to develop and upgrade agricultural goods, increase value and prices of agricultural goods and food, including correct and appropriate allocation of areas for agricultural production and forest to upgrade farmers' quality of life under the policy of Ministry of Agriculture and Cooperatives set to change Thai farmers into Smart Farmers with Smart Officer as a coach. Smart Farming will receive information from air quality monitoring stations and soil quality monitoring stations from various spots installed within the plantation which would be compiled and transmitted wireless to the computer. The information could be followed up based on real time from numerous channels, including program showing output program on a central computer in the plantation or seeing information on the internet via website enabling the smart farmer to supervise and manage his or her plantation all the time wherever he or she is and whether with the use of computer, tablet, or smartphone.

Therefore, if a farmer is already smart farmer, or being considered as such, or in the process of submitting the request to be smart farmer, he or she must have clear and complete knowledge and understanding of the concepts and theories on Smart Farming which will be extremely useful for the development of his or her own agricultural profession for progress and security. Knowledge can also be enhanced for the community and create many benefits for agriculture which is the main profession of most people in the country since the time of their ancestors to be able to develop until output can be exported to the global market with the quality and the GAP standard and is price competitive compared with other countries (Database of Promotion and Upgrading of OTOP Products, 2021).

2.2 Concept and Theory of Knowledge Management

Knowledge management aims to support work of Knowledge Worker for more efficiency. It is the mechanism that comes from collection of scattered knowledge into one place, creates the atmosphere of people to invent, resulting in new knowledge. The most important thing for knowledge storage is to create channels and conditions for exchange of knowledge for efficient development.

The main components of knowledge management can be divided into 3 parts namely 1) People is the most important component as it is the knowledge source of an organization, and the users of knowledge 2) Tool and technology is the tool used to search, store, exchange, and apply knowledge simply, conveniently, and fast and 3) Knowledge process is management to take knowledge from knowledge source to users leading to work efficiency and creation of innovation in performing tasks (Porntida Vichienpanya, 2004).

Therefore, knowledge management means collection of knowledge scattered, tacitly, or in documents that is systematically developed, to enable all employees in an organization to have access to knowledge and develop themselves as experts, with efficient operation, resulting in the organization's high competitiveness. Knowledge is divided into two types namely 1) Tacit Knowledge is knowledge gained from experience, gift, or instinct of an individual in understanding of things. It is the knowledge that cannot be easily transferred into words or written form such as skill in

craft, or analytical thinking. Sometimes, it is called abstract knowledge. 2) Explicit Knowledge is the knowledge that can be transferred through various methods such as record in written form, theories, handbooks. Sometimes, it is called concrete knowledge.

2.2.1 Objectives of Knowledge Management

The main goal of knowledge management is to make use of knowledge that has been collected, stored, analyzed and formulated. including the dissemination of knowledge for the efficiency and progress of the organization through the support of computer and information technology for collection and dissemination General Objectives of Knowledge Management are as follows (Porntida Vichienpanya, 2004)

- 1) To make the organization aware and see the importance of the knowledge contained in the individual and in the organization by applying that knowledge for maximum benefits and efficiency. both in terms of work and lifestyle
- 2) The use of computer technology and information technology to apply in systematic knowledge management, such as disseminating knowledge through the agency's website The use of intranet systems to contact and change knowledge within and between departments
- 3) To create and develop improve the infrastructure within the organization By applying the knowledge gained from knowledge management to be useful, such as a care system to help learners in educational institutions Personnel selection system to work, etc.

2.2.2 Types of Knowledge

Knowledge can be divided into two types (Kittiphan Khongsawatkiat, 2010), namely explicit knowledge and tacit knowledge. or Tacit Knowledge. Explicit knowledge is knowledge that is described in letters such as work manuals, books, journals, etc., while latent knowledge is knowledge that is embedded in most people. It is a latent knowledge that may exist in people working in organizations or departments. and specialists in each field Therefore, knowledge exchange mechanisms are required, namely, knowledge management as follows:

1) Explicit Knowledge is knowledge that can be easily managed and collected. It is organized and transferred using digital methods. There are raw materials (Objective), concepts and theories. It can be coded to convey by official methods such as corporate policies, concepts, methods of work, etc.

2) Tacit Knowledge is knowledge that cannot be explained using words. It is knowledge that is rooted in action and experience in a way of life. May be characterized as beliefs, skills, such as occupational skills, basketry skills, etc. In-depth knowledge requires practice to achieve proficiency. There are personal characteristics such as organizational culture, skills, expertise in various fields, etc.

2.2.3 Knowledge Level

Knowledge useful in the operation of an organization or agency is divided into 4 levels namely (Chiraprapha Akaraborworn, 2009)

- 1) Know-what is the knowledge of facts, clear knowledge acquired from study and learning
- 2) Know-how is the knowledge that connects and applies for implementation
- 3) Know-why is the complicated knowledge based on reason and
- 4) Care-why is the creative level and innovation at work Knowledge management procedure

2.2.4 Knowledge Management Procedure

Consists of 7 processes (Porntida Vichienpanya, 2004) as follows:

- 1) Indicate knowledge is the consideration to reach the goals, the necessary knowledge, the types of knowledge, the forms of knowledge, the owners of the knowledge
- 2) Create and search for knowledge
- 3) Systematize knowledge to lay down the knowledge structure to prepare the systematic knowledge in the future
- 4) Compile and screen knowledge
- 5) Access to knowledge to ensure that knowledge users have easy and convenient access to the knowledge such as IT system, PR boards, etc.

6) Exchange of knowledge done with many methods. In the case of Explicit Knowledge, it can be done as document of IT knowledge

7) Learning should be part of work such as learning system from knowledge creation for application, resulting in new, continuous, and circular learning and experience

Knowledge management consists of main processes such as search for knowledge, creation and search for new knowledge, systematic knowledge management, processing and screening of knowledge, sharing and exchange of knowledge, and learning. The tools for knowledge management are divided into 2 groups namely 1) Tool that facilitates “access” to knowledge such as ICT and 2) Tool that facilitates “transfer” of knowledge mainly in the form of exchange of learning and sharing and interaction between individuals.

2.2.5 Concept of Tuna Model Knowledge Management

Tuna Model (Porntida Vichienpanya, 2004) is a simple, uncomplicated concept appropriate to serve as the guideline for knowledge management by dividing the knowledge management, similar to fish, into the head, the body, and the tail. Each part has different roles as follows:

- 1) Knowledge Vision (KV)- Direction and response to the question “Why KM?”
- 2) Knowledge Sharing (KS)-The part which is the core that places importance on exchange of learning and mutual assistance
- 3) Knowledge Assets (KA) creates knowledge source, links network, applies IT, “tail wagging”, create power from practical community (Porntida Vichienpanya, 2004)

2.2.6 Trends of Thai Agricultural Development under the Change of Thai Agricultural Society

Guidelines for the development of Thai agriculture to strengthen the national economy. Sukhothai Thammathirat Open University (2017) as follows: (1) improve the quality of life of farmers (2) develop production capability (3) develop agricultural resources efficiently balanced and sustainable; (4) strengthening farmers and farmer

institutions; (5) enhancing the efficiency of agricultural product management throughout the supply chain; and (6) enhancing agricultural competitiveness through technology and innovation. Trends of Thai agricultural development under the change of Thai agricultural society are (1) the development of the agricultural sector to strengthen the national economy, (2) the development of agriculture that is environmentally friendly, and (3) the development of agriculture for security. way of food

Nowadays, modern farming that is becoming a trend all over the world. It is full of technology and innovations in agriculture. which was used to develop farming methods Facilitating the lives of modern farmers (Smart Farmer) in almost every aspect, including helping to solve problems in terms of decreased agricultural land due to the expansion of urban society. unpredictable weather conditions less number of farmers impacts from disasters, etc., in order to still have sufficient production to meet the consumption demand of the world population. therefore the development “Modern Agricultural Innovation” Agriculture suitable for Thailand as a guideline for farmers and entrepreneurial innovation have led to the development of agriculture and create new opportunities For related businesses, for example, as shown in Figure 2.4 “AgTech” trends that change the future of “Agriculture” Thailand

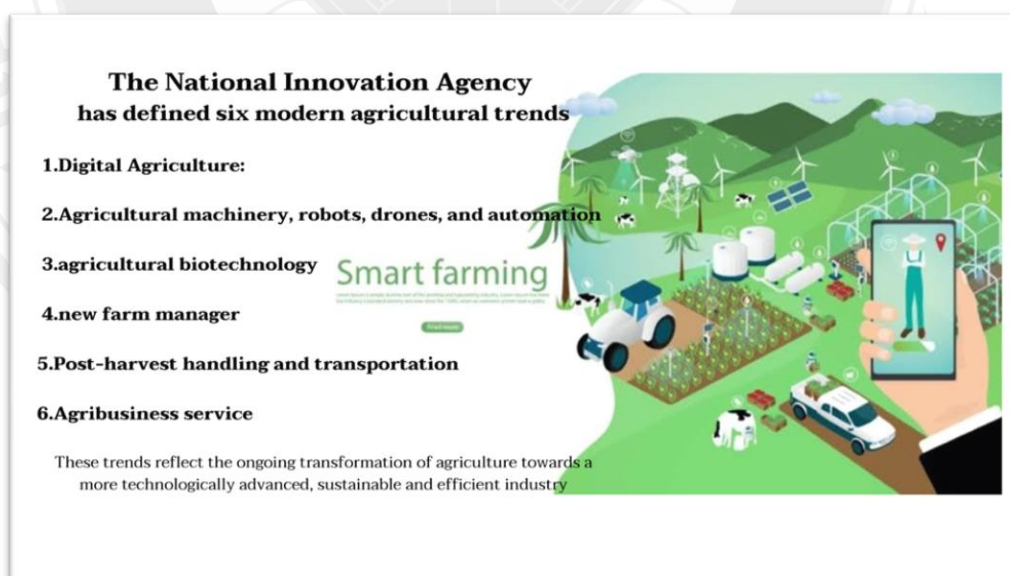


Figure 2.4 “AgTech” Trends that Change the Future of “Agriculture” Thailand

Source: National Innovation Agency (Public Organization) [NIA] (2021).

1) Digital Agriculture (Agriculture) is taking advantage of collecting data on agriculture, including soil conditions, water conditions, temperature, humidity, light, cultivated areas, growth situation, etc., which will make it possible to understand the problems and needs that differ from area to area. Help find suitable farming practices. The most accurate and efficient for farmers. The important thing is that farmers can use existing data to extend along with artificial intelligence (AI), for example, using AI to help control crop fields. The farmers hardly have to go down and mix by themselves. were used to analyze the differences of weeds in agricultural plots. to find a way to get rid of it on the spot or to analyze the risks caused by weathering to help reduce the risk of disease increase productivity. (NIA., 2021)

2) Agricultural machinery, robots, drones and automation (Agriculture Machinery Robots, drone and automation) Although the demand for agricultural products increases with the world's population But on the other hand, the number of farmers present is diminishing. Innovations in agricultural machinery, robots, drones and various automation systems therefore plays an important role to help farmers save time save labor but still producing the same output or more than ever But the benefits of using these innovations Not just good as a power saver It also means increased efficiency, lower costs and improved quality of life. to farmers, for example, Israel's first AI robot that will work automatically when the flowers are ready for pollination in suitable temperature and humidity The chances of success are higher than if left naturally, or the use of drones to grow rice with precision and can double production.

3) Agricultural biotechnology (Agriculture Biotechnology) Agricultural biotechnology It is an application of a variety of sciences, including biology, chemistry, and agricultural knowledge. to develop microorganisms for agricultural applications gene modification improve plants or animals To become products, businesses and solutions to agricultural problems, biotechnology has begun to be widely used in the agricultural industry, such as the utilization of microorganisms in the soil. To encourage growth and be resistant to drought conditions. resistant to weeds Reduce the use of fertilizers and pesticides. or even breeding animals to be resistant to epidemics

4) New farm management: (Smart Farming) In the past, the lives of farmers hung on the risk. It all depends on the weather conditions which are difficult to control. Until the problem of unstable productivity. Therefore, it became a new trend in farm management. that improves the efficiency of the production process regulate growth factors of plants and animals and help farmers not have to worry about damage to their crops. An example of a new type of farm that is becoming popular is the plant factory system that can control the environment. Both providing water, light, temperature and humidity that are suitable. which in addition to helping plants grow well Can also grow crops out of season. Vertical farming trend (Vertical Farm) suitable for urban farming solve the problem of lack of cultivated land Including making trends “Insect farms”, the protein source of the future that the world is watching (NIA, 2021).

5) Post-harvest and transportation management) The challenge issue for Thai farmers is that it is a tropical country. which resulted in various agricultural products have thin skin easy to rot causing the farmers to not sell their produce in full. Therefore, it is the source of innovation development that is of great interest. Environmentally friendly packaging and storage Non-chemical life extension process Including a convenient and accurate production quality inspection system does not destroy the productivity and innovations that can be transported quickly after harvest, such as ozone-controlled containers which extends the shelf life of the berry group. Allowing farmers to change transportation via boats instead of planes. or the development of new coatings by skilled startups, AgTech, Thailand, etc. (NIA, 2021)

6) Agricultural business services (Agribusiness Services) Despite knowing that AgTech innovations will benefit their careers But with the agricultural industry structure Most of them are medium to small scale farming. causing the farmers to not be able to invest in buying their own innovations therefore became a trend for agricultural business services That allows farmers to borrow agricultural innovations in a tangible place, such as a reservation system for spraying fertilizer drones, spraying pesticides, a reservation system for agricultural machinery, etc., as well as a platform for selling agricultural products online. Help farmers reach consumers without going through the middlemen. solve the problem of depressing the

price of produce and help connect farmers with consumers, industrial factories or restaurant and allow them to trade continuously (NIA, 2021).

2.2.7 Sustainable Agricultural Development

Sustainable Agricultural Development (Sukhothai Thammathirat Open University, 2017) refers to agriculture that emphasizes on balancing the cycles of people, economy, society, resources and environment. in the nature of agricultural production management that does not focus on the quantity of output alone but focusing on conservation and rehabilitation for better conditions and must be able to meet the needs of farmers today To create opportunities for future generations of farmers in the development of sustainable agriculture. All parties must give priority to cooperation. in developing agriculture for true sustainability starting at the household, community and national levels to world class The importance of sustainable agricultural development is that farmers can be self-reliant. able to reduce expenses, generate income Good health and environmental protection As a result, the community is strong. Reduce competitive advantage and competition The balance of nature and the environment. and the country was at peace. can reduce the inequality gap and develop natural resources and the environment The impacts that affect sustainable development occur in 3 aspects: economic, social and environmental. It affects the development of agriculture to make it very sustainable. It is therefore imperative to rethink the approach of agricultural development that focuses not only on quantity measurements. But must take into account the balance of economic, social and environmental aspects. Along with the development of agriculture to occur at 3 levels, namely the household level, the community level and the national level.

2.2.8 Factors Affecting Farmers' Decisions

Factors that affect farmers' decisions (Bongkot Suebsaeng, 2011) consisted of 6 aspects as follows:

- 1) Physical factors are factors related to inanimate things that change relatively slowly. which consists of Topography, climate, soil, water and factors related to facilities such as transportation, etc.

2) Biological factors are factors related to living organisms, consisting of plant species, animal species, weeds, diseases and insects that are pests or animals. that causes damage to crops before harvesting or reducing yields The biological environment thus influences agricultural production.

3) Economic factors (economic factors) are factors related to production, distribution, output, exchange and community consumption which consists of Capital used in production Land/ area of operation Labor Product price Capital/source of capital Income/return Tools, agricultural machinery production/manufacturing process Production and output management

4) Social factors are factors related to people or groups of people as members of society, such as traditions, cultures, beliefs, races, religions, and various social groups. on the personalities of farmers

5) Political and administrative factors are factors related to the exercise of power. Decisions made by the country's executives in formulating and implementing administrative policies. laying down rules for society to be peaceful, consisting of political parties/systems, political parties, political status economic development plan domestic trade policy International trade policy Government policy Manufacturing/processing promotion policy Act/Law Trade Agreement/Treaty

6) Environmental factors (environmental factors) are factors that occur naturally. which is living and there is no life created by nature or by man-made environments. Indicators showing how conditions are occurring and how the environment is changing include deforestation, land-use pattern changes, and climate change. biodiversity and pollution

2.2.9 Agencies Related to Agricultural Extension and Development

Agencies related to agricultural extension and development consist of (1) government agencies involved in agricultural extension and development; (2) private sector agencies involved in agricultural extension and development; and (3) non-regional agencies. State and (4) international agencies related to agricultural extension and development as follows (Sukhothai Thammathirat Open University, 2017)

1) Government agencies involved in agricultural extension and development are: (1) Government agencies responsible for agricultural extension

work under the Ministry of Agriculture and Cooperatives. Under the Ministry of Natural Resources and Environment and under the Ministry of Interior and (2) relevant government agencies supporting agricultural extension work under the Ministry of Agriculture and Cooperatives. Under the Ministry of Interior and under the Ministry of Education with a mission to promote and support the promotion is to provide services to all people Promoters of government agencies must carry out agricultural extension work with all farmers and cover all areas. Promoters are change leaders whose duty is to bring behavioral change to individuals. The goal of the government's agricultural extension work is to provide agricultural services to improve farmers and communities for a better living. The roles and responsibilities of promoting and supporting the promotion are (1) setting the country's agricultural extension policy (2) being a source of agricultural knowledge and information (3) promoting and developing farmer institutions (4) being as a supporter of production factors for farmers; and (5) as a co-operator and coordinator with other agencies.

It can be concluded that government agencies have a mission. Roles in agricultural promotion, from setting up policies, being a source of agricultural knowledge and information. Promote and develop farmer institutions support production factors for farmers and to cooperate and coordinate with other agencies which includes agencies under the Ministry of Agriculture and Cooperatives and agencies under other ministries

2) Private sector agencies involved in agricultural extension and development also known as Business organizations operate in promoting agriculture in the form of private businesses with the goal of making profitable operations. The goal of the operation of business organizations is to make profits, able to operate and grow. Therefore, in the operation of these organizations, there must be an analysis of the feasibility of the business and the returns that will be received. Make the scope of the agricultural promotion of business organizations. Have clear operational goals Professionally managed Modern technology is used in the operation for maximum efficiency. with the mission of the private sector to promote and support the specific business promotion will focus on one specific purpose in order to be able to sell products or do business did not develop a wide career path NGO projects are dotted with specific villages. Private agricultural extension plays an important role in

enabling farmers to prosper. because of academic works and research will be processed into agricultural products

The concepts and working principles of business organizations are: (1) adhering to the principle of agricultural extension based on the philosophy of sufficiency economy; (2) adhering to the principle of comprehensive agricultural promotion based on the principle of increasing efficiency; and (3) promoting the development of agricultural research. The roles and responsibilities of private sector agencies in promoting and supporting private sectors in production, trade and services are as follows: (1) Being an agency that often has its own products (2) is only interested in the profit of the unit. their work; (3) representatives of the agency often become intimate with farmers; (4) provide advice and knowledge of the agency; and (5) the objectives of the agency will not change. (Sukhothai Thammathirat Open University, 2017)

The financial institutions of the private sector to promote agriculture, in addition to relying on cooperation between the government, state enterprises, private sector agencies in production. Trade and service It also has to rely on funding from financial institutions to support it in order to achieve the goal. It has a role in promoting agriculture of the private sector that hopes for profit, namely promoting the integration of farmers. Promote integrated farming development of agricultural villages Promote and develop careers for targeted farmers in a comprehensive manner Promoted projects will be implemented through strategic planning that prioritizes and takes into account customers, environment, community, society, shareholders, employees and all stakeholders. Transferring the most efficient technology derived from research and development to farmers. Encourage farmers to have opportunities and have alternative occupations. and coordinate development projects with other agencies Related The private sector that seeks for profit related to the promotion and development of agriculture is a private business organization. Distribution of agricultural inputs and purchase of agricultural products. Private sector agencies that aim for profit will participate in the promotion of agriculture in terms of capital, academics, modern technology and marketing, which can be divided into 2 groups: The private sector in production, trade and services and the financial institutions of the private sector.

3) Non-Governmental Entities Non-governmental organizations or may be known as Non-Government Organizations: NGOs, sometimes called NGOs for short, or the United States called Public Voluntary Organizations: PVOs, and collectively known as Public Interest Organizations. is an organization that It was established to work for the common good on some or many specific issues. with a mission to promote and support the agricultural extension of the agency which has roles and responsibilities of non-governmental agencies in promoting and promoting marketing and management capabilities relying on community savings and credit organizations People-Centered Development Giving communities and community organizations the backbone of development development that emphasizes cooperation and synergy between various parties involved in a multilateral manner and the promotion of civil society The tendency of roles in agricultural promotion is to continuously create and develop farmers' leaders in the community. Encourage more activities to support productivity, encourage farmers and target groups to come together and carry out activities continuously by coordinating with other agencies, both government and private sectors. and should not withdraw immediately upon completion of the project but should be a mentor and encourage continuous activities.

4) International agencies related to agricultural extension and development

(1) The Food and Agriculture Organization of the United Nations, commonly referred to as FAO (Food and Agriculture Organization of the United Nations: FAO), is a special agency of the United Nations established with the goal of ensuring food security. food Ensure that all people of the world have access to sufficient high-quality food to sustain life and good health. It has a role as an organization that aims to promote mutual well-being. It has a policy to promote and develop agriculture. improving nutrition and creating food security. Therefore, the FAO has set the objectives of the establishment of the organization as follows.

(1.1) To raise food and nutrition standards

(1.2) To increase the productivity and allocation of world agricultural products.

(1.3) To improve rural conditions

(1.4) To develop the world's economy to free mankind from hunger.

The roles and responsibilities of the organization are (1) collecting, analyzing, interpreting and disseminating information on nutrition, food and agriculture, (2) supporting studies and research on natural resource conservation, (3) providing technical assistance, and (4) operating according to Objectives and needs of the organization International Standards Commission

(2) The Codex Alimentarius Commission, commonly referred to as the Codex, is a public international organization. It is an Intergovernmental Body established in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) to address food safety. Has a role in food safety Promote cooperation in the implementation of food standards by international organizations, both public and private agencies. Promote coordination of all food standards prioritizes and recommends the preparation of draft standards Prepare the final details of the standard. and revising such standards to be up-to-date at all times

(3) Office of the International Plant Protection Convention. (International Plant Protection Convention: IPPC) is an international convention that the parties signed and ratified together under. The responsibility of the Food and Agriculture Organization of the United Nations (FAO) to protect Protect plants from infestation or spread of pests. Its role is to establish international cooperation in controlling and preventing the spread of pests. International standards for phytosanitary measures have been established. (International Standards Phytosanitary Measures: ISPMs) to implement countries' phytosanitary measures. have consistency Its purpose is to ensure effective prevention of the infestation and spread of pests transmitted to humans, plants, plant products and other materials. that have the potential to be vectors of pests

(4) The World Organization for Animal Health (OIE) is a public international organization. (intergovernmental organization) responsible for Improving animal health worldwide It plays an important role as the only international animal health reference organization. which is accepted internationally

And benefit from the veterinary services from the direct cooperation of all member countries. OIE has specified the following operational objectives.

(4.1) Transparency: To provide transparency on the global animal epidemic situation.

(4.2) Scientific data: Collect, analyze and disseminate veterinary scientific data.

(4.3) Solidarity: strengthen member states' solidarity in animal disease control.

(4.4) Sanitation safety: Issue animal health requirements to be used as central standards.

(4.5) Promote and support veterinary service activities: Improve the legal framework and resources of the national veterinary service.

(4.6) Food Safety and Animal Welfare: Ensuring that food from livestock products is food safe. and promote animal welfare management based on scientific data.

Therefore, the concepts and theories about farmers is the development of agricultural personnel Cooperatives and related fields are accepted by all sectors by reducing redundancies in forms and organizational structures. A study of role models of the private sector in public investment projects. push for proactive work Establish and develop internal control systems for agencies involved in agricultural management. Cooperatives and related fields to meet the standard criteria. and supporting mechanisms to monitor operations at all levels in order to ensure good governance It is accepted by all sectors. Improving operations with emphasis on participation and develop information technology management systems in the agricultural sector The guidelines for the development of Thai agriculture to strengthen the national economy are as follows: (1) improving the quality of life of farmers (2) improving production capacity (3) developing agricultural resources efficiently balanced and sustainable; (4) strengthening farmers and farmer institutions; (5) enhancing the efficiency of agricultural product management throughout the supply chain; and (6) enhancing agricultural competitiveness through technology and innovation. There are agencies involved in agricultural extension and development, consisting of (1) government agencies involved in agricultural extension and

development (2) private sector agencies involved in agricultural extension and development (3) government agencies non-governmental agencies; and (4) international agencies involved in agricultural extension and development. When the farmers who are Smart Farming have been developed completely. It will strengthen confidence and pride in the way of professional farmers who can produce quality products and services. Encourage agricultural occupation to have standards that are acceptable for development and competition in terms of quality and price, without having to be a burden to the government if loss occurs from non-standard production, or oversupply of products produced without understanding of market conditions and competition (Sukhothai Thammathirat Open University, 2017).

2.3 Concepts and Theories on Farmers' Learning

Learning (Pitooon Thongchim, 2015) means the process that people change their behavior relatively permanently due to experience. The objective of learning management is to reach the goals as set by vision, strategy, and work procedure to ensure efficiency. For example, reduction of mistakes, improvement and development of procedure to keep abreast with changing situations to ensure effectiveness, reduce costs, and create innovation such as develop brainstorming, apply new concepts, develop people to ensure that personnel are learned, flexible in their work, and satisfied with their work.

2.3.1 Nature of Learning

Consists of the following (Pitooon Thongchim, 2015).

1) Learner's objective means what the learner wants to learn or learns without goal. The person does not know why he or she should learn. This will come to nothing. Instructor should understand the goals of learning or training and the benefits.

2) Readiness is specific to the learner, including the maturity of the learner. The prepared learner will learn better even if in the same situation. Therefore, readiness should be created for the learner to prepare him or her to be ready to learn.

3) Situation means environment or stimulant that affects the learner such as instruction methods, and various situations. People or animals can learn well when exposed to real experience.

4) Interpretation of meaning is the study to reach the goal or make planning to reach the goal by making use of environment or situations. The accomplishment of objectives has many methods but only one is the best method. What method people choose depends on the ability of interpretation.

5) Implementation is when the interpretation of a situation is done, the learner will immediately respond to the situation or stimulant. The action is what the learner expects to be the best method to reach the goal.

6) Outcome after the response to the stimulant or situation. The result may succeed according to the goal with satisfaction. If it does not succeed, it will cause dissatisfaction. The success will stimulate to undertake the same activity. The failure to achieve the goal may result in discouragement to respond or behave further.

7) Interaction to disappointment is done in 2 aspects namely improve one's own action to achieve the goal by looking back or interpret the situation or stimulant again and then find the appropriate action or behavior to achieve the destination. Or one will not undertake the activity again or repeat the same actions without any result.

2.3.2 Major Components of Learning

Consist of the following (Pitoon Thongchim, 2015):

1) Motivation. While being alive, when the body has needs or is unbalanced, there will be a hidden force or stimulation that will drive the needs to disappear so that the body is in a good equilibrium. Motivation is an important component of learning because it is a major engine or real source of behavior.

2) Incentive is the thing that will reduce stress and lead to satisfaction. Psychologists believe that incentive is the core or heart of the hidden situation of learning and activities all derive from incentives.

3) Obstacle is another important foundation of learning because an obstacle will create a problem. When a learner encounters a problem, he or she will change behavior to overcome the obstacle to achieve the goal.

4) Activity or response. It is the part that tells us if someone achieves learning or not and how fast or slowly. The thing may refer to the hidden mental thinking. It can be observed that people will always like the activities that bring success or satisfaction even if they do not encounter a new problem. The activities or behavior that never bring success are usually avoided.

Principles of learning (Yingsak Kraipinit, Thirawat Chantuk, & Phitak Siriwigong, 2019) are as follows:

1) Intention to learn is a necessity that will ensure that learning will be fruitful. This is clear that in the case when farmers voluntarily go to listen to explanations or for training, it will be fruitful. The desire to learn may derive from interest in any issue on farmer, to solve problems, or as knowledge and new concepts, or stimulation from promotion officials and neighbors, resulting in the desire to learn new things.

2) Good beginning. Generally, first impression is hard to forget. It means that the first time a farmer meets a promotion official or in a meeting or training, the beginning is important. It is first step that motivates the farmer to be more interested with the feeling that the beginning forges good relationship, casualness, resulting in the efficient instruction in the future.

3) Know and understand the practical guideline that leads to the goal. The target individual or farmer must understand what guideline or activity that must implement to reach the objective. He or she must know what to do to achieve the result such as attending meeting or training to listen to officials' explanation, reading of documents as assigned, or work in the process as received. If the farmer knows his or her duty clearly, the learning will be faster. The impact will occur if the farmer does not receive clear advice to understand the practical guideline so that the farmer is left in the dark without seeing the direction, goal, or objective.

4) Practice by oneself: Learning results from activities. As for the learner himself or herself, it may be official or spiritual activity or both. The learner must practice to experience the change in behavior which is creation of learning. As

for the duty of instructor, knowledge is the ranking of the teaching process that leads to learning by stimulating learners to participate in the instruction activities. A lot of practices will increase efficiency in learning. But practice should appropriately leave the space depending on the topics of teaching, activity, and learner. After learning, if it is not used or reviewed, it will be forgotten.

5) Relationship or continuity in learning. The learning in each topic that is continuously related will make learning better than if the learning is not related to anything. The learner will understand more easily if relationship is known through explanation such as assembling of a small part to a big part, or a big part is broken down into a small part. Learning with continuous relationship is a method that works well with farmer with accumulated knowledge. The farmer will see the relationship between new and old topics. Generally, the learner will learn better if the topic with related internal relation is used for teaching.

6) Satisfaction with learning results: Whether learning will give satisfaction or not, generally the learner will learn better if the instruction is interesting, in good environment, and learning is gratifying. Especially when the learner feels that there is progress from leaning, and success. People like to do things that will result in progress and success. But they do not like failure. The creation of environment to stimulate the interest in participating in the project to promote agriculture to farmers necessitates public relations, invitation to those interested in participating in the project via mail, radio, television, or other channels, organization of meetings, advice on various issues to farmers, classroom or meeting room should be arranged in order to attract interest, and with convenience in terms of seats and equipment. The atmosphere should also be casual with welcoming introduction, etc. Moreover, the principles of persuasion, relationship between individuals, recreation, use of psychology should be used to communicate and create stimulating atmosphere.

7) Arrange organizational structure for common planning. Participants should be promoted to discuss within the small group to jointly plan promotion in any matter. Promotion official must know the technique of leading discussion group. Relationship must be maintained within the group to jointly express opinions, and teamwork. Relationship has open and trustful nature. Therefore, the theory and skill on social psychological process should be used.

8) Study and analyze the needs of farmers' learning. The work at this stage starts with the creation of desired capability criteria which may derive from the concept of experts from work research, profession research, or promotion course research. Later, the assessment is conducted for the current conditions of farmers if they lack in anything. If so, how can the lack respond to the need of education. How to make learners accept or recognize the need?

9) Determine the objectives of agricultural promotion project which focus on the needs of the learner by allowing the learner to determine his or her own direction. The official acts as advisor and formulate joint planning. The process to determine the objectives is therefore a psychological method that stresses the interpersonal relationship such as the theory of humanism of the psychologist Carl Rogers. But the determination of the objective according to the type of behavior of Gagne or Bloom may be useful in arranging the learning situation to suit the target behavior in each type. For example, the objectives of teaching are divided into the types of knowledge and understanding, skill, attitude, interest, and norm by separating them. Therefore, tasks in this field, knowledge on psychology on the classification of the behavior in the theory of learning and theory of advice need to be studied.

2.3.3 Promotion Planning

The arrangement of the promotion plan has the relevant processes (Yingsak Kraipinit et al., 2019) as follows:

1) Arrange the order of the content that will be promoted by adhering to the principle of difficulty-easiness, the principle of major and minor parts, the principle of cause-effect, and the principle of reason.

2) Prepare the process to entail learning process such as practice to solve problems, practice to make decisions, practice of role playing, development of norm, practice of skill, practice of attitude, etc.

3) Arrange the format of promotion by using promotion methods in group or individual or social activities in the form of advice, orientation, or promotion management in numerous forms. It is necessary to use the knowledge on learning psychology to ensure correct determination and effective implementation. Activities depend on the choice of techniques of media and audio-visual equipment. How to

promote to meet the objectives? How will the authorities promote to reach the objectives? The strategy to persuade farmers to participate in learning is used to assess the results to know if the farmers accomplish the objectives and goals as initially planned. The performance of the promotion officials must be assessed at this stage. There must be survey, success analysis, weakness, fault of the project, as well as farmers' behaviors which change such as knowledge, attitude, farmers' ability to operate.

4) Disseminate knowledge: The promotion of agriculture is the process of education or the process of instruction that focuses on the promotion to disseminate knowledge, innovation, advanced technology to target people in the rural areas namely farmers and families to acquire learning in new techniques or new concepts in agricultural profession so that problems are solved and profession is improved for more development and progress. The teaching of farmers is a process that focuses on advice to the learners to learn what they want. In other words, it is action that causes the change in the desired behavior of the learner which may be either knowledge, attitude, or skill, or all of them as follows: (1) Knowledge such as knowledge and understanding on many issues such as types of seeds, species of pigs and breeding of pigs, type and amount of fertilizer, and benefit of cooperative (2) Attitude is the change of feeling and thoughts and expression of mental feeling such as stop being superstitious, accept new opinions, have faith in cooperative system, want to learn new things, tend to agree with the official, etc. (3) Skill has 2 types namely skill in thinking is the ability to think, do, create, solve problems, create guideline to deal with problems such as able to plan plant cultivation system, able to design a pigsty for integrated farming, and skill in action or formal skill such as able to graft the mangoes, able to drive the tractor equipped with disk harrow, or operate cooperative business. The promotion and dissemination of knowledge is a teaching process that is relevant to learning process which is inseparable. It involves teaching of target people or farmers to generate learning in the learned subjects or academic subjects that will be useful in the farmer occupation. Teaching is the activity with processes leading to the final process which is the learner learns or behaves.

2.3.4 Entrepreneur and Agricultural Entrepreneur

In terms of the study of entrepreneur, academics give entrepreneur various definitions. Successful entrepreneur must also have appropriate qualifications which is a major factor. Moreover, the general characteristics of entrepreneur in business operation is different from farmer. Therefore, the definition of farmer is different from general entrepreneur.

Entrepreneur (Yingsak Kraipinit et al., 2019) means the one who initiates investment and accepts risks at the moderate level from business operation by combining factors of production and intelligence, ability, experience, production technology, and appropriate management to produce goods or products. He or she is also enthusiastic in seeking own direction and with determination to follow own thinking to reach the target. He or she also wants success, and uses opportunity and resources for profit and progress of own organization.

The concept of the characteristics of an entrepreneur (Frese, 2000 as cited in Yingsak Kraipinit et al., 2019) is as follows:

- 1) **Autonomy:** Characteristics of independence at work by using ability and intention to expose oneself to the opportunity, able to work by oneself, able to decide under stress, make decision independently and responsible for own decision, leading to unity at work and hope that business meets the goal and is successful, self-confident, love freedom, self-reliance, self-confidence, resolute and strong to overcome obstacles.

- 2) **Innovativeness:** Entrepreneur's creativity is the characteristics of the entrepreneur who succeeds, who does not want to do things the traditional way, applies experience to create new methods which are better, often dreams of rectifying and improving products, production process, and operation, dares to produce goods that are different from the traditional market, dares to use selling technique unlike others, dares to present new goods in the market and use new technologies in production, tries to replace with new raw materials, expand new markets, use knowledge on modern management to improve work for efficiency and reduce production costs. Creativity can happen by itself or can derive from the ideas of inventors, researchers, or experts already studied and commercially applied. Creativity involves new goods, new services and technology, innovation.

3) Risk taking: The characteristics of risk taking of an entrepreneur is to accept the risk at moderate level. Business and risk run in parallel. Good entrepreneur does not avoid risk (at moderate level) and is ready to face problems, will reap happiness and great pride if successful in the work that others fail or dare not take risk. The risk at the moderate level which is possible between 50 - 60 % as entrepreneurs generally like work that is challenging to knowledge and ability and avoid work with risks that are too high. For the risk at moderate level, the good entrepreneur assesses that it is not beyond one's ability to succeed. The effort in reducing risk consists in choosing various alternatives in business operation by using the time to study and plan marketing and choosing the production that is appropriate to raw materials, machine, equipment, capital, and management, and financial return under the economic, social, political conditions, as well as the government's policy. The decision of good entrepreneur will be assessed in detail from various factors. Good entrepreneur is confident in business with low risk and must take risk at the moderate level. Unnecessary risks must be avoided. The decision with higher return will face with higher risk. Risk taking is divided into 3 types namely: risk taking for things that are not known, risk taking to use a lot of assets to set up business, and risk taking to borrow a lot of assets.

4) Competitive aggressiveness: In operating business of the same type, although profit is the ultimate goal, it is not necessary to compete until one falls down. The method to succeed in business operation of the same type may be different. For example, focus should be on product development, quality, services, reduced production costs, etc. The concept of mostly successful entrepreneurs operates business in the form of partnership, not only winners but through creative cooperation so that all businesses survive. Cooperation can be in the form of setting up clubs to negotiate with the government in solving the problems of raw materials, restructure taxes that are not fair or prevent dumping from abroad. However, cooperation to unreasonably increase the prices, monopoly, hoarding should not be undertaken as they will not be good in the long run.

5) Stability and learning orientation: Entrepreneur's disappointment or discouragement derive from learning from experience with mistake and as lesson learned so as not to repeat the mistake. Events are seen as the opportunity to learn

about work, the opportunity to study and find new methods to solve problems in order to change work for the better. Knowledge from the past experience may not suffice. Good entrepreneur must strive for additional knowledge all the time, including general knowledge on economy, politics, society, law, and others to conduct correct analysis of situations. Good entrepreneur must regularly learn from changing situations, as well as strive for knowledge from others, training, seminar, advice from guru or expert and experience from external or foreign study tour.

6) Achievement orientation: Entrepreneur likes challenging work which in turn motivates work to succeed and better than before. Successful entrepreneur or producer must take into account quality and efficiency, whether quality of raw materials, efficiency of production process, and efficiency of marketing. As for organization management, the entrepreneur and service provider must also take into account quality of raw materials presented to customers and efficiency in service management with great service-minded attitude. Good entrepreneur must set the targets for operation including short, medium, and long targets. The targets must be feasible based on actual facts together with the environment of social conditions. Setting the target requires concrete practice to efficiently reach the target and must know one's standing by doing what one does best.

Agricultural entrepreneur has the paradigm of integrated economy with community with focus on the process to increase value to agricultural products or produce new products in the industry all the time. Therefore, agricultural entrepreneurs will have attitude, characteristics, and behavior that are superior to farmers. Farmers are those who produce agricultural raw materials with income from the sales of the agricultural raw materials. But agricultural entrepreneurs are those who manage agricultural business with the intention to expand business, with leadership and ability management to reach the goal. They are also relevant to innovation, creativity, value creation, and search for opportunities.

Therefore, in terms of the concepts and theories on farmers' learning, in the rural society, most practice agricultural profession. Rural and urban entrepreneurs are different. The change of role from farmer to entrepreneur is therefore important to the farmers' adjustment and the country's economy. Urban and agricultural

entrepreneurs are different. Urban entrepreneurs will focus on business and profit. But agricultural entrepreneurs are various. The characteristics of the entrepreneur is important to succeed and enable farmers to succeed in agricultural business. The characteristics of entrepreneur must be developed. Successful farmers in agricultural business must develop the characteristics of agricultural entrepreneur. The behavior of agricultural entrepreneur consists of 2 main parts namely management skill that is necessary to operate farm business with profit and mentality of entrepreneur that comes from inside such as attitude that inspires the entrepreneur such as focus on the production of goods that are safe for consumers as if the produced goods are for consumption in their own family and concerns for the negative impact on environment, health, and hygiene.

2.4 Concept and Theory of Relevant Policies and Strategies

2.4.1 The 20-Year Strategy for Agriculture and Cooperatives (2017-2036)

Thailand's agricultural sector plays an important role in producing agricultural products and food for the country and continuously exporting them to the world, as well as being a source of employment and always supporting the impact of economic problems that occurred in the past. Make Thai people still have food security and income to enter the country. However, Thailand's agricultural sector continues to face many problems such as unstable product prices. Improper use of factors of production, degradation of natural resources, and the debt problem of farmer households that remained at a high level. Although the government has always set guidelines and measures to help, but most of them are short-term plans that lack continuity and resolve immediate situations. Foundation for long-term development that will lead to development and systematic problem solving. The Ministry of Agriculture and Cooperatives has therefore formulated the 20-year Agriculture and Cooperatives Strategy (2017-2036) as a framework for the development of the agricultural sector to be able to operate continually and efficiently. This is in line with important strategies and development plans, such as the 20-year national strategy (2017-2036), the 12th National Economic and Social Development Plan (2017-2021),

the reform plan of the National Reform Steering Assembly. (NRSA) and also in line with the Sustainable Development Goals (SDGs), which is a global development of the United Nations.

The 20-year agricultural and cooperative strategy (2017 - 2036) aims to enhance strengths and correct weaknesses to facilitate long-term development of the agricultural sector. to achieve the vision “Stable Farmers The agricultural sector is prosperous. Sustainable Agricultural Resources” by strengthening farmers and farmer institutions. Increase production efficiency and raise the standard of agricultural products. Increase competitiveness in the agricultural sector with technology and innovation, manage agricultural resources and the environment in a balanced and sustainable manner. and develop the public administration system Thailand has the strength of being the world's top exporter of agricultural products and products such as rice, rubber and cassava. Farmers have local agricultural wisdom that has been handed down in each locality. Weaknesses Most agricultural areas (119 million rai or about 80%) are outside the irrigation area. Causing to rely on rain water for agriculture Agricultural products are produced in inappropriate areas, for example, rice is planted in inappropriate areas, approximately 8 million rai, an opportunity for the world's population to increase. causing more consumption demand especially food safety Which Thailand has the potential to produce Obstacles The world economy is fluctuating. There is more competition and trade barriers. Natural disasters are more severe and have a higher frequency of occurrence (Office of Agricultural Economics, 2017).

The 20-year strategy for agriculture and cooperatives (2017 - 2036) consists of 5 strategies as follows:

Strategy 1: Strengthening farmers and farmer institutions with the goals of 1) Farmer's average income of 390,000 baht/person 2) All farmers are Smart Farmers 3) Farmer institutions have 95% strength at level 1 and 2. The development guidelines are: 1) Strengthening farmers and agricultural institutions Smart Farmer, Smart Group, Smart Enterprise 2) Fostering pride and security in the agricultural profession 3) Managing agricultural labor by bringing innovation and technology. to apply The indicators are: 1) Farmer's per capita income (Baht/person) 2) Percentage of farmers who are Smart Farmers to farmers of working age (18 - 64 years old) 3) Percentage of

farmer institutions that have Strength at the standard level. 4) Number of farmers who are members of the farmers' institutions. (an average of 15 people per group) and 5) the well-being index of farmers.

Strategy 2: Increasing production efficiency and upgrading agricultural product standards with the goals of 1) increasing agricultural GDP by at least 3 percent per year 2) standardized farms, factories and establishments 3) large-scale farming 90 million rai, 14,600 plots, with guidelines for improving production efficiency and product quality standards Promote agriculture throughout the supply chain in line with market demands. The indicators are as follows: 1) Agricultural GDP increased. (percent per year) 2) Percentage of the number of farms/factories/establishments under the supervision of the Ministry of Agriculture and Cooperatives applying for certification Percentage of Plots/Farm: Crops/Fishery/Livestock Percentage of factories/business establishments (GMP/others): plants/fisheries/livestock 3) large plots (Agriculture/Horticulture/Livestock/Fishery) 4) The amount of land has been adjusted to suit Agri-map production and 5) The growth rate of export value of agricultural products and products.

Strategy 3: Increasing Competitiveness in the Agricultural Sector with Technology and Innovation The goals are 1) research, technology and innovation. It has been further developed, leading to utilization of 80 percent. 2) All farmers have access to and use research, technology and innovation to take advantage The development guidelines are: 1) Developing technology and innovation for driving agriculture in line with Thailand 4.0 2) Managing information technology for agriculture 3) Developing research results in agriculture leading to commercial innovation production The indicators are: 1) the ratio of the research budget to the annual budget of the Ministry of Agriculture and Cooperatives; 2) the percentage of research, technology, and innovation that has been further developed for utilization; 3) the percentage of farmers and service users who Technology has been transferred to be applied.

Strategy 4 Management of agricultural resources and the environment in a balanced and sustainable manner. The goals are 1) 10 million rai of sustainable agricultural land 2) 2 million rai of agricultural land conserved, improved and rehabilitated per year 3) 49.52 million rai of irrigated land. Sustainable agricultural

resources 2) Restore and conserve agricultural resources to be balanced and sustainable. The indicators were 1) the number of sustainable agricultural areas, 2) the number of conserved, improved and rehabilitated agricultural areas, 3) the number of irrigated areas, and 4) the number of areas benefiting from non-irrigated water sources.

Strategy 5 Development of the public administration system with the goals of 1) All civil servants are smart officers 2) Improve and develop the structure of the Ministry of Agriculture and Cooperatives 3) Improve and develop the law to be modern. The guidelines for development are: 1) Developing personnel to become Smart Officers and Smart Researchers 2) Connecting the work systems of all departments in the Ministry of Agriculture and Cooperatives 3) Improving and developing agricultural laws The indicators were as follows: 1) Percentage of Ministry of Agriculture and Cooperatives civil servants who are Smart Officers; Number of new laws made and the number of laws that have been revised, amended, improved

The 20-year strategy for agriculture and cooperatives (2017 - 2036) aims to resolve weaknesses and strengthen strengths contributing to the long-term development of the agricultural sector to achieve the vision “Stable Farmers The agricultural sector is prosperous. Sustainable Agricultural Resources”, with a direction towards the goal, which is Strategy 1: Strengthening farmers and farmer institutions. Strategy 2 Increase production efficiency and raise product standards. Strategy 3 Increase competitiveness in the agricultural sector with technology and innovation Strategy 4 Manage agricultural resources and the environment in a balanced and sustainable manner. and Strategy 5: Develop the public administration system Agricultural development strategies during the 13th National Economic and Social Development Plan, 5-year period (2022 - 2027)

Office of Agricultural Economics Ministry of Agriculture and Cooperatives As an agency with a primary mission in planning for the development of agriculture and cooperatives of the country This is in accordance with the Agricultural Economics Act, 1979, under the supervision of the Agricultural and Cooperative Development Policy and Plan Committee, has prepared an action plan on agriculture and cooperatives 2023 - 2027 to be a country development plan by branch of

agriculture by It is linked to the national strategy, the master plan under the national strategy, and the national reform plan. (revised version) the 13th National Economic and Social Development Plan (2023 - 2027) and other plans related to the agricultural sector The action plan on agriculture and cooperatives 2023-2027 will be a framework to determine the direction and strategy for the country's agricultural development in the next 5 years for government agencies, public organizations, state enterprises and agencies related to the development of the agricultural sector. both inside and outside the ministry Agriculture and Cooperatives Used as a guideline for the preparation of relevant plans/projects details, both as host and supporting agencies. This will lead to the preparation of the annual expenditure budget request. in line with national strategies and plans at different levels

Conceptual framework for the preparation of the agricultural and cooperative action plan, 2023 - 2027 of environmental analysis of the agricultural sector by analyzing internal factors by analyzing strengths and Weaknesses towards the agricultural sector and analysis of external factors by analyzing opportunities and obstacles, as well as trends in future significant changes that may affect the development of the agricultural sector. which will allow can be analyzed in all dimensions Including considering the national strategy master plan under the national strategy The 13th National Economic and Social Development Plan (2023 - 2027) and other plans related to the agricultural sector, including the Action Plan for Driving Thailand Development with the BCG Economic Model 2021 - 2027 Action Plan Food Processing Industry Development Phase 1 (2019 - 2027) Strategies and Guidelines for Driving National Trade 2022-2027 Thailand Logistics Development Action Plan (2027) 2023 - 2027) and the 3rd National Tourism Development Plan (2023 - 2027), including the Sustainable Development Goals: SDGs of the United Nations. which is a framework for national development at the international level To cover current and future agricultural contexts. The results of the analysis are essentially linked to the needs and expectations of relevant stakeholders in order to provide a framework for consideration leading to vision determination. Objectives, goals, indicators, issues, development, development guidelines Major Projects and Related Agencies under the Agricultural and Cooperative Action Plan B.E. 2023 – 2027

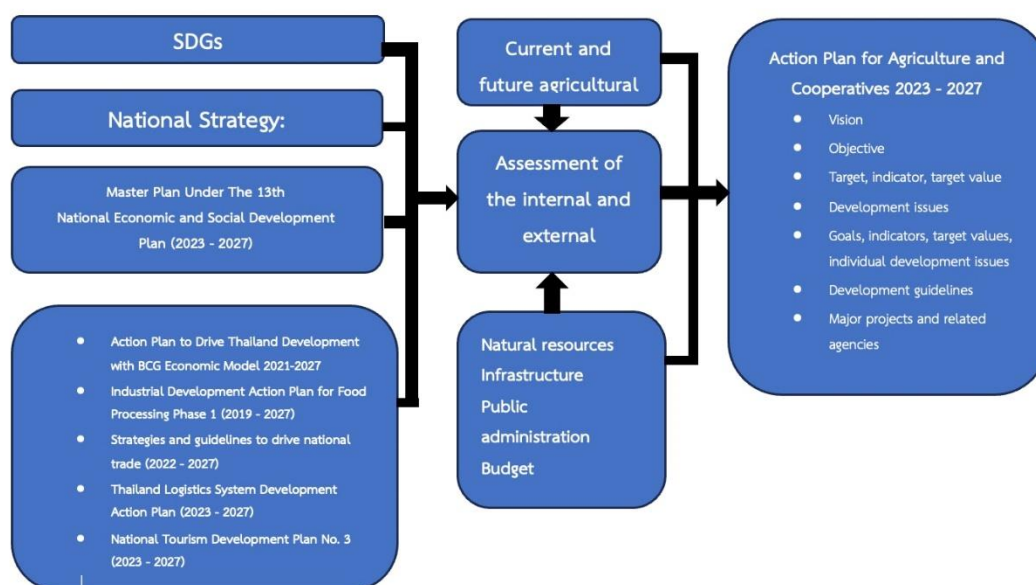


Figure 2.4 The Conceptual Framework for the Preparation of the Agricultural and Cooperative Action Plan B.E. 2023-2027

Source: Ministry of Agriculture and Cooperatives (2022).

2.4.2 Part 3 Concepts, Goals and Development Milestones During The Development Plan No. 13 Principles and Concepts (Draft)

The 13th National Development Plan has the ultimate aim to drive the country's development to achieve results. according to the long-term development goals set forth in the national strategy It aims for the 13th National Development Plan (2023-2027) to serve as a mechanism to address issues that are of high priority for the country's development in the next five years and to push the country beyond various challenges to drive growth that All sectors benefit equally. The (draft) 13th National Development Plan has set directions and Development goals based on four key principles and concepts are:

Philosophy of Sufficiency Economy by inheriting, maintaining and extending development according to philosophy of the sufficiency economy which is based on moderation and reasonableness building good immunity

The concept of Resilience, which is a concept that focuses on reducing vulnerability to change, which consists of developing competency at 3 levels, namely

(1) Cope means the ability to manage under crisis conditions. to be able to stand up and resist hardships Including recovery (2) Adaptation (Adapt) means adjusting the direction, form and development approach to be in line with the changes. Ready to diversify risks and adjust in a timely manner to seek Benefits from what happened (3) Transformation for sustainable growth means structural and fundamental changes to be in line with the changes.

The United Nations Sustainable Development Goals, which are based on the concept of “Leave No One Behind”, aim to enhance the quality of life for all groups of people. both in the dimension of having the necessary factors for sufficient basic living having a good environment Having factors that support complete health both physically and mentally having the opportunity to use one's potential to create well-being including forwarding natural resources and a good environment for the next generation

BCG economic model, which is the concept of economic development in 3 forms simultaneously, namely the bio-economy circular economy and green economy based on the potential and strength of A country comprised of biodiversity and cultural diversity. along with the use Benefit from the knowledge of science, technology and innovation to create added value. To drive the country to have sustainable economic growth. and able to distribute income, opportunities and wealth thoroughly

Development objectives and goals Therefore, there are objectives transforming Thailand into "Progressive Society Sustainable Value-Creating Economy", which means creating comprehensive changes at the structural, policy, and mechanistic levels, aiming to build a society that keeps pace with the dynamics of the world. and support Thai people to have the opportunity to develop The 13th National Development Plan has set five main goals as follows:

Production restructuring towards an innovation-based economy by elevating the capacity of higher competition in key manufacturing and service sectors And able to meet the development of technology and society in the new era and is environmentally friendly.

Human development for the new world by developing Thai people to have skills and characteristics suitable for the modern world, both knowledge skills and

behavioral skills and characteristics according to good social norms Prepare quality manpower that meets the needs of the labor market.

Toward a Society of Opportunity and Justice By reducing inequality in terms of income, wealth and competitive opportunities of the business sector. Support and help vulnerable groups and the underprivileged transition to sustainability by improving the use of natural resources in production and consumption To be effective and consistent with the capacity of the ecosystem. Solve major pollution problems in a sustainable way Especially air pollution, garbage and water pollution. and reduce greenhouse gas emissions

Strengthening the country's ability to cope with change and risk; under the context of the new world by creating readiness to deal with and seek opportunities from an aging society Climate change, epidemics and cyberthreats. develop infrastructure and Institutional Mechanisms Facilitating Digital Transformation as well as improving the structure and administrative system of the public sector (United Nation, 2023).

2.4.3 Development Milestones The 13th National Development Plan has 13 Development Milestones Derived from The Development

milestones established are of an integrated nature. which can lead to development in terms of economy, society, natural resources and the environment at the same time, making each goal can support more than one primary goal The 13 milestones can be divided into 4 dimensions as shown in Figure 2.6 “Mission to Transform: 13 milestones to transform Thailand (Office of the. National Economic and Social Development Council [NESDC], 2023).

2.4.3.1 Targeted manufacturing and service sector dimensions

Milestone 1. Thailand is a leading country in high-value agricultural and processed agricultural products.

Milestone 2. Thailand is a tourism destination that emphasizes quality and sustainability.

Milestone 3. Thailand is an important production base of electric vehicles in the world.

Milestone 4 .Thailand is a medical and health center of high value.

Milestone 5. Thailand is an important gateway for trade, investment and strategic logistics of the region.

Milestone 6. Thailand is an important global manufacturing base for smart electronics.

2.4.3.2 Economic and Social Opportunity Dimensions

Milestone 7. Thailand has strong SMEs with high potential and competitiveness.

Milestone 8. Thailand has areas and smart cities that are livable, safe, and grow sustainably.

Milestone 9. Thailand has reduced poverty. All Thai people have adequate and appropriate social protection.

2.4.3.3 Sustainability of Natural Resources and Environment

Milestone 10. Thailand has a circular economy and a low-carbon society.

Milestone 11. Thailand can reduce the risk of impacts from natural disasters. climate change

2.4.3.4 Factors driving national transformation

Milestone 12. Thailand has a high performance manpower. Focus on continuous learning to meet the needs of future development

Milestone 13. Thailand has a modern government. efficient and answer the questions of the public

2.4.4 Development Milestones

The 13th National Development Plan has 13 development milestones derived from The development milestones established are of an integrated nature. which can lead to development in terms of economy, society, natural resources and the environment at the same time, making each goal can support more than one primary goal The 13 milestones can be divided into 4 dimensions as shown in Figure 2.5 “Mission to Transform: 13 milestones to transform Thailand. (Office of the National Economic and Social Development Council, 2023).

2.4.4.1 Targeted manufacturing and service sector dimensions

Pin No. 1 Thailand is a leading country in high-value agricultural and processed agricultural products.

Pin 2 Thailand is a tourism destination that emphasizes quality and sustainability.

Pin 3 Thailand is an important production base of electric vehicles in the world.

Pin 4 Thailand is a medical and health center of high value.

Pin 5 Thailand is an important gateway for trade, investment and strategic logistics of the region. Pin 6 Thailand is an important global manufacturing base for smart electronics.

2.4.4.2 Economic and Social Opportunity Dimensions

Pillar 7: Thailand has strong SMEs with high potential and competitiveness.

Pin No. 8: Thailand has areas and smart cities that are livable, safe, and grow sustainably.

Pin number 9: Thailand has reduced poverty. All Thai people have adequate and appropriate social protection.

2.4.4.3 Sustainability of Natural Resources and Environment

Pin 10 Thailand has a circular economy and a low-carbon society.

Pin 11 Thailand can reduce the risk of impacts from natural disasters. climate change

2.4.4.4 Factors driving national transformation

Pin 12 Thailand has a high performance manpower. Focus on continuous learning to meet the needs of future development

Pin 13 Thailand has a modern government. efficient and answer the questions of the public



Figure 2.5 Mission to Transform: 13 Milestones to Transform Thailand

Source: NESDC (2023).

2.4.5 Section 4 Strategic Plan by Milestones

2.4.5.1 Thailand is a leading country in high-value agricultural and processed agricultural products.

Past development situation Recent developments in the agricultural sector Emphasis on production for export and as a raw material for the industry. Continuing to generate income into the country through the expansion of cultivated areas Developing quality factors of production Continuous development and use of technology It found that there are still important issues that need to be clarified, improved and upgraded in order to reduce constraints and facilitate the production of high-value agricultural and processed agricultural products, namely technology and innovation. Specific modern agriculture is not yet used much. A large number of agricultural sector databases There is still a lack of connection and use in the

management of the agricultural sector. understanding about Adding value from environmentally friendly agricultural production is still limited, such as economic tree planting. Agritourism The crop insurance system has yet to incentivize farmers to voluntarily purchase insurance. Food Processing Innovation There are still a number of technology patents. food industry that is less than foreign countries Although there is a food innovation city and worth investing in research and high development n The market for high-value agricultural and processed agricultural products is unclear, such as medical food, health food, medicinal plant essences, biochemicals, and marketplaces for agricultural products and products are still limited. unable to deal with flood/drought risk accepted destination market Different agricultural product safety standards Collection, transport and distribution system of agricultural products Modern and efficient today is not enough to meet the needs. and need to be improved Modern and fast management.

2.4.5.2 Development goals

1) Linkage of the milestones to the main goals of the 13th National Development Plan and the national strategy (NESDC, 2023).

(1) Thailand is a leading country in high-value agricultural and processed agricultural products. have a connection with the main goals of the 13th development plan draft in 3 goals out of 5 goals, namely

(1.1) Restructuring manufacturing and service sectors towards an innovation-based economy by upgrading the competitiveness and the local economy and small entrepreneurs can be connected to the value chain and the local economy and Micro-enterprises can be linked to the value chain of targeted manufacturing and service sectors.

(1.2) Development of people for the new world
By supporting quality manpower in line with the needs of the target manufacturing sector

(1.3) Toward a Society of Opportunity and Justice
By reducing inequality in terms of income and stability, including opportunities for competition in the business sector. and giving vulnerable and underprivileged groups the opportunity to move up the economic and social strata

(1.4) Transition to Sustainability by using natural resources to produced and consumed efficiently and in line with the carrying capacity of the ecosystem; and

(1.5) Strengthening the country's ability to cope with risks and changes in the context of the new world, whereby Thailand has the capacity to cope with significant future threats. especially climate change, severe epidemics and emerging diseases. and cyber threats The goal of the first milestone, when considering the linkage with the national strategy, found that it was consistent. with 3 national strategies:

(2) Competitive capacity building in the goal

(2.1) Thailand is a developed country. stable and sustainable economic growth; and

(2.2) Thailand has higher competitiveness There is a master plan under the national strategy, agricultural issues that focus on upgrading the production level to meet the quality and safety standards Taking advantage of the prominence and uniqueness of agricultural products Including biodiversity in each area to create value for agricultural products. application of modern technology and innovation in production and farm management

(2.3) Opportunity Creation and Social Equality in the goal of creating fairness and reduce inequality in every dimension There is a master plan under the national strategy. Basic economic issues that focus on the integration in the form there a concrete income distribution structure for the economy and community and has a mechanism to drive the economy foundations by bringing together the power of various sectors, including the private sector, civil society, and local communities. And strengthen the community

(2.4) Building growth on the quality of life that is friendly to the environment in utilization and growth goals on the basis of natural resources and the environment to balance within ecosystem capacity There is a master plan under the national strategy. Sustainable Growth Issues That emphasizes growth that emphasizes the principles of utilization, conservation, preservation, restoration and rebuilding. Sustainable Natural Resources and Environment Base Do not overuse natural resources, do not create pollution to the environment beyond the capacity of

the ecosystem to support and heal. including production and environmentally friendly consumption

2) Goals, indicators and target values of milestone level development

Goals, indicators and target values of milestone level development As detailed in the National Economic and Social Development Plan as shown in Figure 2.7, the linkage between the development milestones and the main goals. (NESDC, 2023).

Goal 1 Increase the added value of agricultural and processed agricultural products.

Indicator 1.1 Gross Domestic Product in the agricultural sector grows at 4.5 percent per year.

Indicator 1.2 Net income per farmer's household is not less than 537,000 baht per household. At the end of the 13th Development Plan

Indicator 1.3 Sustainable Agricultural Areas Increased to 10 million rai at the end of the 13th Plan

Goal 2 Develop infrastructure and management systems for quality, food security and sustainability of the agricultural sector.

Indicator 2.1 The agricultural sector has an average Total Productivity (TFP) of 1.5 percent at the end of the 13th Plan.

Indicator 2.2 There are 2 regional agricultural market centers in the North, 2 in the Northeast, 2 in the South, 1 in the Central and 1 in the East at the end of the 13th Development Plan.

Indicator 2.3 Water flowing into reservoirs throughout the country is at least 40,000 million cubic meters per year at the end of the 13th Development Plan.

Indicator 2.4 The irrigation system is at least 75 percent efficient. At the end of the 13th Development Plan

Indicator 2.5 Reuse of water in non-irrigated agricultural areas Not less than 20 percent of the area at the end of the 13th Development Plan

Indicator 2.6 Areas that can reduce the risk of flooding and drought and a community water management system for 4,000 sub-districts at the end of the 13th development plan

Goal 3 Increase the potential and role of agricultural entrepreneurs as partners in the economic chain. Proper and fair share of supply

Indicator 3.1 The number of agricultural cooperatives in Level 1 according to the criteria for cooperative strength rating increased. At least 18 percent at the end of the 13th Development Plan

Indicator 3.2 The number of farmers groups in Level 1 according to the criteria for grading the strength of farmers groups increased. At least 6 percent at the end of the 13th Development Plan

Indicator 3.3 Number of community enterprises at a good level According to the criteria for grading the strength of community enterprises increased At least 35 percent at the end of the 13th Development Plan

Indicator 3.4 Increased agricultural entrepreneurs (according to the estimation of the Ministry of Education) 4,000 cases per year

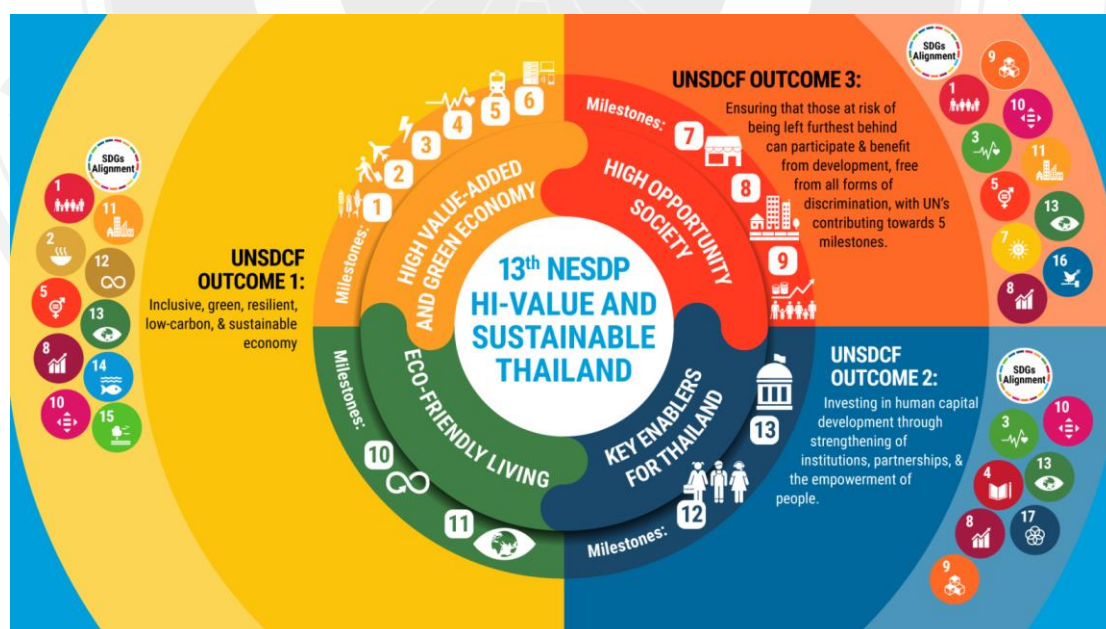


Figure 2.6 Link between Development Milestones and Key Goals

Source: NESDC (2023).

2.4.6 Development Strategy

Strategy 1: Targeted application of technology and innovation to achieve the upgrading of the production process and create added value Support research and development of technology and innovation in production and processing with a targeted approach. with the participation of the private sector Promote and expand research results from research agencies Universities and vocational institutes, the private sector, and farmer organizations contribute to the development of innovative technologies. to achieve use Benefit from research results and create engagement between technology developers and users.

Strategy 2: Production promotion and market expansion of agricultural products and processed agricultural products with high added value, such as safe agricultural products processed herbs medical food Biomaterials and Chemistry plant and insect proteins Encourage the development and business of processed agricultural products with high added value future market potential Formulate a roadmap for developing and promoting the production and use of biological products. produced from agricultural raw materials wastes from the agricultural production process and other by-products

Encourage farmers to apply science, technology, innovation in a variety of production processes, including the use of agricultural data warehouses. in analyzing, planning, developing productivity and production efficiency

Strategy 3: Expanding sustainable agricultural models that are friendly to the environment and have high added value from the model. Success in the country such as agriculture according to the BCG economic model, safe agriculture, agroforestry, organic agriculture. Agricultural tourism local fishing legal fishing and fair treatment of labor Promote sustainable agriculture that is aware of its impact on the environment and development. based on natural habitat through protection operations Sustainable Management and restore nature or system a changing ecosystem support the necessary inputs to achieve the expansion of the agricultural form It is environmentally friendly and has high added value.

Strategy 4: Development of water management systems for agriculture to balance between supply and demand. Including the reuse of water, promoting and pushing to increase the area of the watershed / economic forest that can generate

income. in areas unsuitable for growing plants Including increasing the amount of natural water to have sufficient water for the whole system. Accelerate the development and rehabilitation of irrigation systems and water distribution in irrigated areas. and develop and manage water sources outside the irrigation area of local government organizations.

Strategy 5: Encouraging private sector investment in the development of central markets and online markets for agricultural products, including livestock and fishery products. Develop supporting factors that facilitate and incentivize private investment and develop regional central markets/community markets. Encourage data collection of comparative agricultural prices between regional markets. and the central market continuously Develop knowledge and skills for farmers to be able to buy and sell their produce through an online marketplace for agricultural products such as crops, fisheries and livestock.

Strategy 6: Supporting the insurance system and certifying the quality standards of agricultural products and agricultural products. processed that farmers can access increase the efficiency of the agricultural insurance system to diversify and suitable for the production of agricultural products Implementation of reduction in farmer transaction costs associated with Applying for certification of various standards throughout the supply chain to increase access opportunities and incentives for farmers There is a production of quality products that meet even more standards. Support the role of the private sector in linking standardized farmer produce. to enter the agricultural supply chain to create value

Strategy 7: Improving farm management efficiency and post-harvest activities to reduce costs and increase the value of farmer's output Supporting the role of farmer institutions (Cooperative/Farmer Group/Community Enterprise) as a business unit of farmers to support the efficiency of farm management. post-harvest activities and the process of delivering products to the end customer to reduce costs and add value to the produce of farmers. Develop infrastructure and facilities for collecting and transporting agricultural products.

Strategy 8: Encouraging farmers to have land and maintain suitable agricultural areas as production bases Agriculture supports and promotes the systematic allocation of arable land for farmers through existing mechanisms such as

allocating arable land for communities. According to the government policy (NTC.) and land allocation of the office agricultural land reform Protect potential agricultural areas and expand access to arable land. of farmers more Including the determination of suitable areas for agricultural use.

Strategy 9: Development of databases and data warehouse related to agriculture. including pushing for the use of information effectively Agricultural data warehouse system to be linked together And it is open data to serve as a base for further application in increasing the efficiency of agricultural production and creating added value in the future. especially information related to Natural resources such as water, soil, forest, sea

Strategy 10: Developing a food security management system Encourage communities to have access to food security in terms of quantity and complete nutrition, including a food reserve system in a variety of ways, safe and sufficient, and support for Model area for community food reserves Prepare to manage the distribution of agricultural and food products in times of crisis.

Strategy 11: Upgrading the capabilities of farmers and farmer institutions Develop further knowledge and skills in farm management and agribusiness operations in the digital age. To raise the ability of farmers to become smart farmers with high potential. as well as supporting the role of the private sector and educational institutes both at the vocational level and higher education in the area as a service provider technology transfer and business consultant to connect information, knowledge and technology with business transformation and expansion

Strategy 12: Development of mechanisms to connect various parties, including the private sector, the government sector, farmers groups, and academics in the area. in economic partnership in the development of the agricultural sector throughout the supply chain Support the role of organizations or farmers' councils in government, private and academic cooperation mechanisms in each province. to link farmer production and business operations Agriculture of the local farmers institutes in accordance with the potential of the area. The needs of the private sector at the provincial level Promote the role of the private sector in economic partnerships with farmer institutions and farmers in various business forms. (NESDC, 2023).

2.5 Concept and Theory of the Circular Economy

Circular Economy is the mechanism that drives towards sustainability from the efficient use of natural resources. It is development to create balance between human and nature for smart reuse of natural resources. Circular economy is the concept of reprocessing and reuse of used resources focusing on the use of resources with the maximum efficiency to solve the problems of excessive use of resources due to the growth of global population and the problems of waste management. The economic growth and the increased population result in the exploitation of limited natural resources to continuously drive the growth of the economic system. Due to the excessive exploitation of resources, competition for resources that tend to diminish in terms of raw materials and energy, and the lack of security of resources, the Circular Economy is therefore rectifies the balance between humans and resources through the reuse of used resources by efficient energy to reduce carbon emission and accommodate the increased population in the future towards the blue carbon society. It is forecast that in 50 years from now, the world will increase the consumption of resources three folds in 2050 and tremendous amount of carbon dioxide emission. The Circular Economy is therefore the way out that leads to the transformation of efficient use of energy and raw materials to maintain the balance between humans and resources that also successfully leads to the goals of sustainable development. (Office of National Higher Education Science Research and Innovation Policy Council (NXPO, 2021).

The major principle of Circular Economy is the economy that leads to the use of resources and products as long as possible, reduce garbage or zero waste by adhering to the three important main principles:

Principle 1: Maintain and increase efficient use of natural resources (Natural Capital), control the smart exploitation of natural resources with maximum benefit through efficient technology, integrated management in the system, and rehabilitation of natural resources.

Principle 2: Use resources with maximum benefit through circularity of raw materials and products, design and processing of post-use resources, repair, and recycling to create the circularity of raw materials in the economic system.

Principle 3: Maintain efficient system and reduce negative impact on the use of resources such as use of land, air, water, and climate change.

Based on the three principles of the Circular Economy as mentioned earlier, the extension of the result to the business model to drive the business sector towards the Circular Economy require five dimensions namely design, choice of materials, service, sharing, and reuse. The principles of the Circular Economy will turn the world around and drive the policies of all dimensions, leading to the efficient and sustainable use of resources, stimulating continuous thinking to create new innovations. Design focuses on long service life and reuse, or repeated use. The choice of materials focuses on the recycling of main raw materials for the reuse of resources and reduce waste in the circular production.

Abroad, for example, in 1996, Germany announced the German Closed Substance Cycle and Waste Management Act. Policy on the Circular Economy was added. In 2000, 14% of waste from production could be reused. In 2016, 200,000 positions were created from waste management industries. The money flow in the economic system contributed to over 40 billion euros. In 1996, in China, the Circular Economy principle was used in pollution control. In 2008, the Circular Economy was announced, Law of the People's Republic of China, but was not successful. In 2013, the government announced Circular Economy Development Strategy and Action Plan for Clean Production Eco-Industrial Park and Eco-cities. The government invests in basic infrastructure and seeks cooperation from people and the private sector. Japan succeeds in waste management from production and consumption that is not reused down to only 5%. The government builds the waste separation base at consumer level, electronic waste management fees on the day of purchase and assigns the private sector in co-invest in the development of basic infrastructure of waste management. (NXPO, 2021).

The guideline to drive Thailand's Circular Economy consists of four dimensions namely production, products, resistance with ability for repair and recycling, and eco design. At present, residues are produced as new products with quality and higher value. The principle of Extended Producer Responsibility (EPR) is used in the sales of electrical appliances for little use, repeated use, and reuse. It is the efficient use of resources. Environmental-friendly goods such as goods with energy

efficiency of label no. 5, green label. The used products are processed with the same quality as new products such as smart phones, etc. On consumption, promotion of Green Procurement, Environmental Footprint, products and greenhouse gas emission. Product and service warranty such as goods with green label that considers if the product makes environmental impact compared to other products with the same functioning through the Life Cycle Analysis (LCA). On Waste Management, based on the information of Pollution Control Department, in 2017, the volume of Thailand's waste was as high as 27.40 million tons, divided into the waste with correct disposal 1.70 million tons, incorrect disposal 7.18 million tons, and reuse 6.52 million tons. Thailand sets the long-term goals through promotion of waste management by unlocking the Act to allow the private sector to co-invest in the government's projects, promoting recycling in households, waste disposal through landfill, improve efficient waste management, promotion of recycling, awareness raised for waste separation by using the principle of avoiding waste management using energy, the use of Secondary Raw Materials, development of law enforcement on waste management by which Ministry of Interior drafted the Act on Waste Electrical and Electronic Equipment (WEEE). The section 19 determined the improvement of the design of products for easy reuse and increase the share of the reuse of material or piece from recycle process. On recycled materials, the government promoted the use and development of alternative raw materials from recycling process from garbage or waste. Department of Primary Industries and Mines set up the standards of the use of recycled raw materials and control the contamination of recycled goods. The Notification on waste management 2017 determined the provision of utensils to separate waste (general/organic/recycled/hazardous) by Pollution Control Department. Digital Technologies are used, as well as technology of data and communication management such as Big Data, Blockchain, and Internet of Things (IoT) to follow the data of the use of resources in production process and sales of products. Presently, the Sharing Platform business model uses this technology to facilitate the linkage of information on Physical Technologies, technology related to materials and energy such as the use of Robotics for faster production and increased efficiency, reduce costs and environmental impact, reduce waste in production

process, Biological Technologies with linkages, and bio structure such as bio energy, good and safe bio radiation for consumers.

The economic expansion and consumers' demand of goods and service to use resources in the production system to return to the original state or reuse accommodate the future shortage of resources. The Circular Economy is therefore a concept to drive economy towards sustainable development. It is also in accordance with the Sufficiency Economy Philosophy which is an important principle in Thailand's economic and social development with science, technology, and innovation, leading to planning of efficient use of resources, focusing on the use of the product as long as possible, promoting reuse, separation, or zero waste, enabling post-production or post-consumption garbage or waste to return to production process and reuse of secondary raw materials towards sustainable development (SDGs). The concept is used in garbage and waste management in terms of appropriate technology for waste management and utilization from waste, leading to innovation and development of new products, expansion of industrial sector, employment, profession, reduced negative impact on environment, moving towards low carbon society, driving technology and innovation in garbage or waste management under the principles of the Circular Economy to produce secondary raw materials from garbage or waste, as well as innovation of the prototype of creative community product to generate income for the community as well as development of technology to reduce the negative impact from garbage or waste and appropriate planning of waste management. (NXPO, 2021).

Social participation in the Circular Economy. As the Circular Economy covers all sectors of society from upstream of production process of products, sales, distribution, to downstream with consumers and waste management, everyone needs to participate in the Circular Economy in the entire system, leading to sustainability from the balanced economic, environmental, and social development. Good quality of life starts from the manufacturing sector taking into account ensuing impact on environment, whether waste from production process for reuse, choice of packaging that can be reused as raw material in new production, to responsibility towards consumers in terms of packaging, and volume in relation to the price of the goods. However, there may be limitation in investment in technology that will help in

production change to be able to use the used resources for repeated production replacing new resources, as well as clean production process. Moreover, it may impact labor market that the number of workers may be reduced to reduce costs. At the same time, the business sector distributes goods to consumers and needs to consider collection of packaging that can return to new production process for maximum benefit such as packaging from glass, paper, metal, or plastics can be collected as raw materials for production of new goods and some packaging can be reused several times. For example, glass bottle of a soda can be reused 16-18 times. It is the example of the business sector that has long been seen. Finally, for the destination which is the part of the consumers, it is necessary to recognize the responsibility in choosing environmental-friendly goods or least impact on environment, by changing consumers' behavior, as well as learning to separate waste to be circulated into new production process, benefiting the comprehensive Circular Economy system.

2.6 Concept and Theory of Urban Community

2.6.1 The Concept of Urban Community

Urban communities have evolved with the history of mankind. Ever since humans began to unite as a society It began with settlement as a small community that came together to provide, share and exchange the resources needed to live within the community. Communities in this way have a basic social and economic system. There is a small gathering of people and a predominantly subsistence production system. Later, when one community can contact another community. Community exchanges thus take place. The agglomeration formed a large community with a more complex social and economic system and eventually developed into an urban community. which urban social problems The expansion of the economy on the basis of industry and the popularity of private cars. As a result, urban communities spread apart. causing people in urban communities to be separated from each other Lack of bond between each other and between the community, the people in the city abandoned and destroyed what shows the uniqueness and indicating the original history of their community. resulting in environmental problems from uncontrolled urbanization of

urban areas causing the development of the city to encroach on the natural environment outside the city. People flocked to live outside the city. The city center was left in disrepair. Causing the city to face problems from both air, water and noise pollution that threaten people's health and sanitation. Including the problem of loss of humanity, where modern cities destroy human social structures. The social interactions that once held human beings together are broken, people in the city lack good social relations with each other (Jaksin Noyralphoom, 2007).

2.6.2 Definitions of Urban Community

Urban community means densely populated area. Academics in various fields give additional definitions of urban community as follows:

“Urban community” according to town planning officers means area and characteristics of densely populated as community. The population are mostly engaged in trade, service, industry, and others, which is not agricultural practice. Office and home are situated in the community for convenient contact and use of services.

“Urban community” according to rulers means municipality with densely populated community. It has local administration in response to people’s needs. It is divided into three types namely City municipality, Town municipality, and Subdistrict municipality. The classification of the type of municipality depends on number of population, population density, and income of municipality.

“Urban community” is the source of physical congregation of buildings, roads, center of exchange of goods, education, and service with definite size of population. It is the source of civilization, religion, arts, education, culture, and technology.

“Urban community” means big settlement consisting of permanent buildings such as buildings, and houses, with public utilities such as electricity, water, wastewater treatment, telephones, and footpaths, etc. Urban community is home to a dense, large number of people. Population in each urban community consists of people with different genders, ages, and status. The basic profession of the population is not agriculture. Urban community has its own administration. Another clear characteristic is that urban community consists of several social compositions and also serves as the center of tradition and culture.

Urban community as seen nowadays is large urban community covering many villages with temple as religious center and local rites, market, shops, academic institutes, residential areas of people of various professions, economic center which is interrelated, both village community in the local area and other urban communities, most importantly, center of administration which is the office of ruler or governor. The creation of urban community is therefore a phenomenon in human's social and cultural development derived from village community development which is equal development. The settlement of large and medium urban communities is permanently populated in an area for standards. Higher costs of living, compared to living alone, derive from division of jobs. People have specific professional expertise. Goods and services are produced from the congregation of population and production units promote more specific and highly efficient production. At the same time, the densely populated area also serves as market for the output only. There is easy access to employment sources. Production units in cities may be located near other production units in the same industry or different industries for the benefit of dependency relationship and time-saving from outside. At the same time, consumption can easily gain access to wholesalers and retailers as well. Urban community therefore serves as vehicle bringing together producers and consumers and accommodates the exchange of goods and services in cities (Warisara Laemthong & Arun Sirijanusorn, 2009).

2.6.3 Factors Creating Urban Community

- 1) Urban community will be formed in appropriate position with convenience in communication such as water, rail, road
- 2) Urban community is formed in the position or location with physical environment (focusing on geography) which is appropriate and accommodating to the living of the population in a particular community such as rivers, basins, estuaries, etc.
- 3) Technological knowledge and ability enable humans to transform unsuitable natural conditions into conditions that are suitable for settlement
- 4) People have sufficiently high demand to create urban community
- 5) Cluster of production saves and lowers production costs

6) Accumulation and cycle by which economic activities accumulate and regularly change new patterns (Warisara Laemthong & Arun Sirijanusorn, 2009).

2.6.4 Duty of Urban Community

Warisara Laemthong and Arun Sirijanusorn (2009) All urban communities in the world have many duties in common. Large urban community may have more responsibilities. Some may have some outstanding specific duties. But in general, urban community has the main duties as follows:

- 1) Center of administration. Large urban community at the level of capital of a country or province is location of government complex at provincial and state levels, responsible for administration
- 2) Center of culture, religion, politics, arts, education, etc.
- 3) Center of transport and communication such as airports, ports
- 4) Duty of protection
- 5) Center of recreation
- 6) Center of residential areas

2.6.5 Types of Urban Community

- 1) Administrative urban community is the urban community as center of administration, a capital of a country, with the offices of the central government such as Bangkok (Thailand), Washington D.C. (US), Canberra (Australia), and London (UK)
- 2) Military urban community is the urban community with military bases such as Chonburi is the navy base, Ratchaburi is the location of Engineer Department, Nakhon Ratchasima is the location of the air force's large airport
- 3) Cultural and educational urban community is the urban community of the center of education with many schools and universities, center of religion such as Nakhon Pathom (Phutthamonthon, Phra Pathom Chedi), Mecca (center of Islam), Vatican (center of Christianity), center of history and archeology such as Sukhothai, Ayutthaya, and center of local cultures such as Chiang Mai, Chiang Rai

4) Industrial urban community is the urban community with the locations of numerous industrial plants mainly for production and processing of products such as Samut Sakhon, Rayong, Lampang

5) Urban community as center of communication is the urban community which serves as the center of collection and distribution of goods and services, as well as travels such as Bangkok, Nakhon Ratchasima, Nakhon Sawan, Phuket

6) Recreational urban community is the urban community that serves as seaside resort, sports, and gambling such as Pattaya, Phuket, Chiang Mai, and Las Vegas in US.

7) Residential urban community is the urban community generally situated in large suburban areas. It is residential areas of those who reside in large urban communities and conveniently commute to work such as Nonthaburi, Pathum Thani, Nakhon Pathom (Warisara Laemthong & Arun Sirijanusorn, 2009).

2.6.6 Selection of The Location of Activities in Urban Community

Generally, the principles to select the location for activities in cities consist of the following: local production factors, local obstacles, movement factors, and external demands. The main duties of urban community consist of the following: enabling a large amount of population to gain easy and convenient access to activities, including going to work or on errands, going to schools and universities, selling goods, or shopping. This is because movements of people entail higher costs than movements of objects. As time is valuable, the choice of location for activities is determined by short, fast, and efficient linkage. In the inner city, apart from the mentioned factors, consideration should be taken for dependency of activities situated one close to another. The competition to occupy empty space, impact on neighbors, and saving, or external non-saving. It may be independently situated due to the major reason and that is the activities are determined by outside such as quality of soil, topography, natural conditions. They are the most important things in the consideration of the choice of location due to limited choices such as ports, seaside resorts, airports, etc. The activities need to contact with the outside world. They are the areas that need sufficiently good access to transport such as ports, bus terminals,

airports. Transport junction needs high savings in transport of goods and serves as gateway to the outside world such as Don Mueang International Airport, Suvarnabhumi Airport, Bangkok Port, Laem Chabang Port, Bangkok Railway Station, etc. If there is enough attraction, urban community will be formed with the first activity as the community center. The issue that needs to consider when choosing the location of the activities of the urban community, either large or small, is the land prices of the areas (Warisara Laemthong & Arun Sirijanusorn, 2009).

2.6.7 Types of Land Use

1) Commercial land use: From the bird's eye view of urban community, one will see high rises which are office buildings, department stores, big hotels, restaurants, or even academic institutions congregated at the heart of a city. It is the busiest business or commercial district with little neglected space. Land prices are very high. Further from the area, buildings are lower and less congested. The commercial district is the heart of urban community at the national level. Approximately 10% of the area is situated at the center of urban community with main roads and people can commute easily into the city center. Small urban community has only one commercial district such as in rural areas or in each district. It is generally central market of community. But for big cities such as Bangkok or other provinces such as Chiang Mai, Phuket, and Nakhon Ratchasima, there are many commercial districts such as China Town (Yaowarat Road) as gold trading district, Ratchaprasong district with shopping centers, Phahurat Road as fabric district, Bang Pho as wood furniture district, etc. In big cities nowadays, there have been many changes in commercial buildings. In the past, commercial buildings consisted of the ground floor for commercial purposes and the lodging was in upper levels. Later, it was changed into modern shopping centers with various commercial activities such as cinemas, restaurants, theme parks, swimming pools, and others such as the Victory Monument area, or Siam Square area.

2) Residential land use: The residential area uses up most land in urban community or approximately 30%. The residential area is interspersed with commercial district or public areas, from inner urban community to the edge of urban community. Residential area consists of various buildings such as commercial

buildings, detached houses, semi-detached houses, apartments, and condominiums. Those with medium to high incomes will conduct business and trade in the building which is also their residences. The choice of residence of anyone depends on income, period in his/her life, lifestyle, and travel to work. In big urban community, there are congested residential areas due to high land prices. The residential areas are high rises such as apartments or condominiums. Those with low income mostly live in small, congested areas with low quality and lack of good public utilities. This type of residential area is situated near market or industrial factory which is the source of employment. Traveling expenses to work are down to the minimal. Slums are generally created near shopping centers or scattered in public areas such as community under expressways or at Din Daeng Flats, etc. Those with high income will escape from this polluted environment to suburban areas with wide space, low land prices, and with easy commute to and from work. But whenever congested traffic poses problems, these people may have to purchase condominiums at the center of urban community as well.

3) Public land use: Approximately 15-20% of this area is public area and can be divided into many parts depending on each part of the particular urban community such as government complex, universities, historic towns, hospitals, etc. The details of the guideline in each type of district are as follows:

(1) Government complex: In the past, most government complexes were situated right in the middle of urban community. Nowadays, agencies have grown with more employees, rendering the old location congested. Therefore, due to expansion, new locations are sought and the complexes are located near one another for convenience at work and save both time and public utilities as well as such as Chaeng Watthana Government Complex, government complexes in provinces, etc.

(2) University district (academic community): In the past, the national policy on education was not much promoted as at present. So, academic institutions are not numerous, both public and private. But with more promotion and education distribution policy, residents in the community realized the importance. So, at present, many academic institutions are set up. The establishment of academic institutions greatly accelerate progress to the areas. As the university circles have a

lot of activities and personnel, the areas around the universities are self-developed as well such as communities around Naresuan University, Phitsanulok, Chiang Mai University, Rangsit University, or Dhurakij Pundit University, Prachachuen Road, etc.

(3) Historic towns: The development of historic urban community generally benefits a lot from tourism business, in terms of lodgings, restaurants, or other services to visitors which are changed from neglected areas. Nowadays, historic towns are beautifully restored while retaining complete historical value. Some even belong to world heritage sites such as communities around Ayutthaya Historical Park, Si Satchanalai Historical Park in Sukhothai, Pimai in Nakhon Ratchasima, or Phanom Rung Historical Park in Buri Ram, etc.

(4) Hospital district: Most eligible to become community are generally big public hospitals in provinces with over 500 beds as this type of hospital hires a lot of personnel. The accommodating public utilities must be highly efficient or else hospitals cannot operate. Therefore, community around these hospitals experience expansion, development, and sustainability. They are mostly situated in big provinces such as communities near Crown Prince Hospital in Phitsanulok, Srinagarind Hospital in Khon Kaen, Crown Prince Hospital in Nakhon Ratchasima, and Sawanpracharak Hospital.

(5) Other public areas: Apart from the above public areas which are similar to the centers of small and medium urban communities, there are also communities created from public areas depending on the importance of the areas. Some areas have historical value in parallel with urban community around the areas such as railway station, bus terminal, market, stadium, police station, school, etc. (Warisara Laemthong & Arun Sirijanusorn, 2009).

The community of each size determines land use of industrial purposes at present and in the future such as power plant, water supply, heavy or light industrial plant, industrial estate. The industries situated in urban community are mostly small industries. The establishment of industrial plant at any spot in urban community requires the consideration of the following four factors: (1) Location of industrial plant must be near water sources, raw material, market, transport, main communication route, size and prices of land (2) Pollution, environment around the industrial plant such as noise, water, air pollution, and foul smell that cause troubles

for surrounding residents (3) Convenient access to consumers, providers of goods, and labor force and (4) Relevant laws such as Town Planning Act (must be in line with the map of land use in each area), Building Control Act, Factory Act, and Local Municipal Law. In the beginning, in urban community, industrial plants were situated near city center as it was source of employment and communication was not yet expanded to suburban areas. But nowadays, most industrial plants are located around urban community as they are stipulated by the law of land use (Town Planning Act). With lower land prices, spacious areas, easy communication, the use of land for this purpose constitutes approximately 10%. Moreover, areas are allocated to accommodate the community of industrial town, equipped with public utilities and public assistance, near big logistic area called industrial estate such as Navanakorn Industrial Estate, Amata Nakorn Industrial Estate, etc. (Warisara Laemthong & Arun Sirijanusorn, 2009).

2.7 Concept of CIPPI Model

The concept and the assessment are based on the CIPP Model by Daniel L. Stufflebeam. It is the model that is generally recognized at present. It assesses continuous process. The focus is on its use in parallel with project management in order to find information for decision-making continuously and all the time. The objective of the assessment is to use information for decision-making with focus on the clear division of work between the assessment division and the management division. The assessment division is responsible for identifying, supplying, and presenting information to the management division. The management division is responsible for requiring information and using assessment results for decision-making to operate any relevant activities. The operation is to prevent any bias in the assessment. The assessment can be divided into 4 types as follows: (Stufflebeam, 1971 as cited in Chamlong Poboon, 2017)

1) Context Evaluation (C): It is the assessment to acquire key information to assist in determining the objectives and the feasibility of a project.

2) Input Evaluation (I): It is the assessment to consider the feasibility of a project with appropriate and sufficient resources used in a research.

3) Process Evaluation (P): It is the assessment during the operation of a project to find mistakes in the operation and to use it as information to develop, rectify, and improve the operation for higher efficiency.

4) Product Evaluation (P): It is the assessment to compare the output and the objective of a project or the demand/set target relying on the information from the assessment of environment, initial factors, and process.

Stufflebeam presented the types of decision in line with the assessment issues as follows:

1) Planning Decisions: It is the decision that uses the information from the assessment of environment to determine the objective of a project in accordance with the action plan.

2) Structuring Decisions: It is the decision that uses the information from the input to determine the structure of a plan and the operational process of a project.

3) Implementation Decisions: It is the decision that uses the information from the assessment of process to control the operation according to the plan and improve and rectify the operation for the highest efficiency

4) Recycling Decisions: For example, the decision is made by using the information from output to consider whether to suspend/cancel or expand a project to be used in the future.

In terms of the principles to construct valid indicators (Klang Bandhumetha, 2017), in order to construct valid indicators, it is necessary to have principles to be used as the targets of operation namely (1) Select/construct only the indicators that constitute the key representation (2) Explanation or determination of indicators should be in clear phrases (3) Indicators can be determined both in quantity and quality (4) The objective of a project or an assessment issue should be used to determine the indicator and (5) Collection of the information on indicators should be undertaken from primary and secondary sources.

The division of each type of indicator according to the characteristics of the issue to be assessed in each dimension (Klang Bandhumetha, 2017) is as follows:

1) Indicator on Context: The consideration of the indicator can be made from the following factors:

- (1) Environment before operating a project (critical problem)
- (2) Present and future necessity or need
- (3) Mutual understanding of all involved in a project

2) Indicator on Input: The consideration of the indicator can be made from the following factors:

- (1) Clarity of the objectives of a project
- (2) Readiness of resources such as budget, personnel, tools and equipment, time, and regulations
- (3) Appropriateness of the process between problems, causes of problems, and activities

3) Indicator on Process: The consideration of the indicator can be made from the following factors:

- (1) Inspection of activities, time, and resources of a project
- (2) Recognition of people and agencies involved in a project in a local area
- (3) Participation of people and agencies relevant to a project
- (4) Leadership in a project

4) Indicator on Product: The consideration of the indicator can be made from the following factors:

- (1) Employment rate of poor people
- (2) Income of people participating in a project
- (3) Satisfaction of people participating in a project

5) Indicator on Outcome: The consideration of the indicator can be made from the following factors:

- (1) Quality of life of oneself and family according to standard criteria
- (2) Non migration
- (3) Participation in community development

6) Indicator on Impact: The consideration of the indicator can be made from the following factors:

- (1) Positive impact/expected results from a project

(2) Negative impact/unexpected results from a project (Klang Bandhumetha, 2017).

The criteria and the indicators can be used as tools to efficiently assess the project results covering economic, social, environmental, management, and resource dimensions, etc. Moreover, they can measure the success and the failure of the government's development projects. In practice, the assessors must adapt the criteria and the indicators to suit the characteristics and the context of the project.

In considering the duration of the project assessment, and in dividing the types of the detailed project assessment, the project assessment can be divided into 4 phases as follows: (Chamlong Poboorn, 2017)

- 1) Pre-evaluation: It is to assess the necessity and the feasibility to determine if there should be a project or plan. Sometimes, the assessment is called feasibility study or need assessment.

- 2) On-going Evaluation: It is to assess the project results for monitoring and the use of resources.

- 3) Post-evaluation: It is to assess if the results of the operation reach the objectives of a project.

- 4) Impact Evaluation: It is to assess the results of the project after the project or the plan ends. The objective is to inspect the operation which may be influenced by the project or other factors.

Chamlong Poboorn (2017) presented the technique to assess the results of a plan and a project. CIPP-I Model is the technique to assess a plan and a project that is applied from the CIPP Model of Daniel Stufflebeam et al. (1971 as cited in Chamlong Poboorn, 2017) and the EIA with the following guideline:

- 1) Context Evaluation: It is to evaluate the external factors impacting a plan/project outside the control of the plan/project such as economic, social, political, environmental, technology factors, etc., whether the evaluation of the external factors impact the success or the failure of the plan/project, or whether the evaluation of the plan/project is in line with the external factors.

- 2) Input Evaluation: It is to evaluate whether the input or resources used in a plan/project are sufficient, appropriate, efficient, or with quality. The major input includes personnel, budget, raw materials, materials, equipment, etc. The

evaluation of the external factors will indicate if the success or the failure of the plan/project derives from the input.

3) **Process Evaluation:** It is to evaluate the inspection of the activities and processes, methods of operations of the plan/project whether they are in accordance with the set plan. In case of evaluation during operation, the evaluation of the process will indicate the strengths and weaknesses of the operation in each process, problems and constraints, as well as the appropriateness of the activities and the process of operation whether they will reach the objectives. In case of evaluation after the plan/project ends, the evaluation will indicate the scope of the success or the failure which derives from the process of operation.

4) **Product Evaluation:** It compares the output from a plan/project with the set objectives, targets, or criteria both in quantity and quality. The evaluation can be undertaken during the operation in case the plan/project produces output intermittently and after the end of the plan/project to have an overview of the output from the operation.

5) **Impact Evaluation:** It evaluates the examination of the positive and the negative impacts of a project on target groups and other groups such as communal, economic, social, and environmental dimensions. With consideration of the positive and the negative impacts, the evaluation can be conducted during and after the plan/project ends. The evaluation of potential impact will also contribute to improving or solving problems.

2.8 Examples of Smart Farmers Abroad and In Thailand

2.8.1 Smart Farmers Abroad

EU is the region with economic, industrial, and innovative progress, especially technology and innovation in plant cultivation as plant cultivation has an important role in the economy, society, and food security. It is a source of raw materials for the energy and bio plant sector. The plant cultivation is also an important component to maintain biodiversity, environmental preservation, and rural development of the EU. In EU, the land for cultivation is approximately 179 million hectares or approximately 1,200 million rai. It is divided into the area for plant cultivation (105 million

hectares/657 million rai), permanent pasture (61.4 million hectares/383 million rai), and area for cultivation of perennial plants (12.2 million hectares/76 million rai). Major yields (in 2018) include cereals (295.1 million tons) such as wheat, barley, and corn, sugar beet (119.6 million tons), potatoes (51.8 million tons), vegetables (62.3 million tons), fruits (37.4 million tons), oilseed crops (32.8 million tons) such as rapeseeds, sunflower, soybean, and grapes (25.7 million tons), and olives (12.9 million tons) which constitute the combined output value of 225,000 million euros or 52% of the total value of agricultural yields (India Brand Equity Foundation [IBEF], 2022).

However, EU still faces the limitations of the size of the area and labor force in the agricultural sector, as well as challenges such as increased quantity and demand for consumption which tends to increase 70% by 2050, limitations of agricultural resources, climate change, spread of diseases and pests, social expectations for quality and safe food which is good for health and with low impact on the environment and climate. Therefore, the plant cultivation with the traditional methods focusing on increase of output by increasing areas, use of chemical fertilizers and pesticides that deteriorate soil and water resources are no longer the sustainable methods. It is the drive to use more agricultural technology and innovation. Due to the situations, rules and regulations, trends of market for European food and agricultural goods to develop production efficiency, reduce the use of resources and energy, reduce environmental impact and greenhouse gas emission, in EU at present there is more widespread practice of “Digital farming or Farming 4.0”. These technologies will assist the agricultural sector to cope with challenges and manage production better, leading to sustainable agriculture. Digital farming is the use of IT together with Smart agriculture to develop the complicated farming system with the highest efficiency. Digital farming has 3 main components namely 1) Precision farming, Geo-location service, and Machine learning (ML) to detect data, diagnose, forecast, and give orders for operation with precision such as sensors installed in farms or on tractors or drones, inspection of humidity and nutrients on the agricultural land in each spot to improve the appropriate use of water or fertilizer to reduce the use of water and chemicals 2) Connection of data and integration & automation. Internet of Things (IoT) enable various devices to connect and transmit data through the internet without feeding data,

as well as orders for machines or devices to work automatically such as adjustment of temperature in the greenhouse to suit plant cultivation based on real-time depending on humidity in the soil, plant health, and air condition within the greenhouse. Farmers can follow up and give orders from a distance, from computer in office, smartphone or tablet. 3) Data aggregation & algorithms. Digital farming involves a lot of data both in and outside the farm until it becomes big data which has to rely on methods by computer for analysis, and data processing. Farmers can gain access to platforms with the services for providing data, analysis of data, and advice on farming via applications or web portals such as the application FaST (Farm and Sustainability Tool and Platform) to support sustainable farming and land management in EU, application of AGRICOLUS that assists Italian farmers in precision farming, or online platform WatchITgrow to monitor the growth of plants and support sustainable farming in Flanders, Belgium, etc. (European Commission, n. d.).

Examples of Digital Technology in Plant Cultivation in EU (European Commission, n. d.)

1) Automatic control system in greenhouse Plant cultivation in greenhouse is developed even further with the integration of the function of sensors and the AI and IoT technologies as control system. Plant cultivation in Autonomous Greenhouses, apart from the inspection and control of the environment in the greenhouse such as lighting temperature, humidity, and CO₂), it also works by connecting with robots to prepare the soil, seed sowing to eliminate weeds, and harvest output. This smart farming system can also forecast, reduce mistakes at work, develop output quality, and better use of resources. The automatic control system in the greenhouse is tested with the cultivation of tomatoes in the Netherlands. In the future, it may be used for the cultivation of other fruits and vegetables such as cucumber, sweet pepper, strawberry, flowers, etc.

2) Smart farming technology The cultivation of wheat in France uses the agricultural technology with high precision together with the IoT technology and the data management platforms to assist in the use of water and fertilizer (nitrogen) so that wheat cultivation is more efficient, with reduced impact on the environment, reduced labor force, and higher output. The soybean cultivation project in Italy uses the smart farming technology such as decision support systems, data

from sensor and IoT technology that connects with data and information from various sources to give advice to farmers on the development of quality, efficiency, and sustainability for the soybean cultivation. As a consequence, farmers earn more income from the cultivation of soybean as rotation crop, reduce nitrogen leak in water, increase biodiversity, and soil richness. Moreover, the IoT technology contributes to the transparency and traceability of production of plants/protein animal feed (soybean) which is useful in standard certification and confidence for buyers. The ERMES project monitored rice cultivation in Italy, Spain, and Greece between September 2013-March 2017 by relying on data from European satellite and local data in preparation of digital map which provided the high-quality, near real-time data services and digital maps to develop efficiency in monitoring rice cultivation, and forecasting the output in advance or potential threats such as bio-related risks, and floods, as well as provided information to farmers on the status of the area that was useful for high precision farming. The ERMES project also developed the application “Local Rice Service” which provided information to farmers on the fluctuations of plants, signal warning of risks, damage assessment in each area, as well as advice on the appropriate period and area for the use of fertilizers and pesticides which reduced risk costs on the environment and developed efficiency in rice cultivation.

Singapore is a small country that relies on import of agricultural goods and food

In the past many years, Singapore has striven to promote the new generation of startups to turn to modern farming which saves land and water, and reduces reliance on food import. At present, many vertical farms for plant and vegetables have sprung up, as well as vertical crab and fish farms which are the business that can compete with imported food. A farmer’s indoor vegetable farm is highly efficient. The small farm yields 5-10 tons of vegetables a day. The crab and fish farms have circulating water system which yield high output and greatly reduce loss. These farms use a few workers so the prices are competitive with the imported food. Importantly, food is very fresh which is an advantage for upper markets. Singapore’s new smart farmers conduct their own R&D and also register for patents from their innovation works as well (World Economic Forum, 2021).

Smart Farming in India – Techniques and remedial guidelines

Rice farming has been practiced since the ancient times and farmers are the backbones of the rice farming. Farmers work very hard to produce food from their rice fields to the world. In the past, the farming technique was labor intensive involving a lot of time and efforts. With the passing time, the farming technique changes from labor intensive to capital intensive with high yields and reduced efforts. Smart farming in India is necessary that will help farmers to increase output and income. In this 21st century, phones are smarter than people and farmers depend on the monsoons to determine the time of sowing. It shows the crucial needs to upgrade farming in India. Smart farming in India is equipped with techniques and methods to solve problems. The blog can help increase farm output with lesser effort. (IBEF, 2022)

Smart farming is the farming that relates to higher and advanced output with the existing farming to increase production efficiency and quality of agricultural output. As a result, smart farming increases farmers' quality of life by reducing hard and repetitive work as much as possible.

In short, one can say that smart farming involves waste reduction, output development, optimal resource utilization through long-distance sensor. Smart farming is also known as precision farming as well as the use of technology and internet devices of the IoT, analysis of big data, long-distance survey, AI, and robots. It is scientifically proven that these technologies increase profit, reduce waste, and maintain quality of the environment. India's central government supports smart farming. India's central government has an active role in the development of the agricultural sector. Technology budget is increased to help Indian farmers. The Indian government supports smart farming to reduce poverty and increase output. At present, it strives to double income for farmers by 2022. The successful smart farming will increase income for farmers. As a consequence, the NITI Aayog cooperates with other companies, including IBM for the solution that is technology-driven. These farmers will receive advice real time and financial support to increase their output.

Hi tech products and advanced technology make work convenient with high output. However, smart farming may not be worth the effort for farmers. Even if they want to, they may not adopt smart farming. Most Indian farmers have limited

income which hinders them from adopting digital revolution in farming. Therefore, the agricultural technology in this early stage must prepare the products and services according to the budget for the farmers' fullest advantage. Indians are quite conservative. They believe that the methods or practice since the ancient times are the best for farming. But due to the increased population and the advanced technology, the methods should change too. Therefore, Indian farmers must use technology with new innovation to increase efficiency in smart farming but some technologies need improvement. In terms of the requirements on the innovation of products, as these products experience growth from the past, they need improvement as well. Therefore, new technologies in the market fully design new types of food, products that cannot grow are tested in labs, and digital market allows farmers to rent connecting devices with local clients or grouping for better guarantee. The operating software will help farmers to decide and operate better, save money, and monitor resources or output in modern greenhouse. Farming in India experiences the of greenhouses has also increased in the past few years. At present, the modern greenhouses use automatic control system the requires a lot of technologies and use LED lights for growing environment. Recently, a precision farm company presents the technology that will help Indian farmers increase production by controlling the stress of small weather pests, humidity level, and soil conditions. In practicing precision farming, farmers will receive appropriate techniques for plant cultivation and cultivation that increases efficiency and income. (IBEF, 2022).

New smart farms enable the Philippines to achieve the goal of sustainable agriculture.

The Philippines is striving to improve and strengthen its agricultural sector. Both the public and the private sectors promote the application of advanced technology and smart farming methods to increase harvest and reduce the least loss (Oxfordbusinessgroup, 2018).

Early April in 2018, officials started the smart farm project which was the first to be funded by the government. It was part of the project of Small Plant Production in Controlled Environments (SPICE) with the budget of P128m (2.5 million USD) designed to develop and promote urban farming and plant preservation with advanced technology. It is situated in a nursery of the Department of Science and Technology

for indigenous and local plants in Quezon City. It is in cooperation with the University of the Philippines Diliman and Los Baños University of the Philippines which will serve as the greenhouse for new technologies and modern farming methods.

According to the officials, the technical practices such as vertical farming for small plant cultivation, cold storage, and soilless plant cultivation aim to develop the technology to increase plant yields and reduce the necessity to use labor force. The SPICE project is part of the wider drive to reform, improve, and modernize the sector through the introduction of new technologies and widespread application of technology with the policy direction that is more important as the country's population expands and the problems of food security have become more urgent. The Philippines is one of the countries identified as facing the most risks from climate change according to the 2018 Global Climate Risk Index disseminated by the NGO, Germanwatch in Bonn which ranked the countries most affected by climate change at the no. 5 ranking for the past 20 years. Amid the climate change that happened more frequently of the cycle of the El Niño weather, decreased rainfall and higher temperature cause damage to plant output. During the last important El Niño phenomenon in 2015 and 2016 the harvest yields decreased 4.5% and profit decreased according to the production chain and food processing. Trainings to increase the target of sustainable farming support new smart farmer projects and reduce impact from climate change. The public and private sectors work with farmers to improve understanding about the guideline of sustainable farming. Department of Agriculture through agricultural training institute cooperate with the Social Institute for Poverty Alleviation and Governance to set up a course on agriculture in central Luzon on the best practice on climate, as well as the use of advanced technology and plant and soil management. The education program is crucial in raising awareness of the potential benefit of technology in farming. According to Takashi Sumi, President and CEO of Atlas Fertilizer, a local company, said, "Agricultural technology exists in every country. But farmers must be well educated on the methods and information on benefit." He said to OBG, "In general, machine is considered too expensive for farmers even though it increases harvest efficiency."

Moreover, Monsanto, the Philippines' agricultural MNC, launched the smart farm project in February to train corn growers. The nationwide project will enable farmers to learn new technologies, and improve cultivation and corn cultivation, as well as use of corn with the high yield and disease resistant varieties. This project is located in 16 smart farm centers nationwide. The target is to reach 20,000 growers in the first year. Apart from the efforts to increase output and profit, the focus on sustainable farming techniques is expected to create a lot of business opportunities for the agricultural service providers. The method of modern farming that is forecast and the use of machine to reduce own burden should increase the demand of farm devices and supporting services in the rural area. At the same time, the use of greenhouse irrigation and the increasing shift to organic production may increase the demand of materials and devices for fertilizer technology and relevant seeds, and necessary funding to reach the target of smart farming.

Apart from the study and the training, the transition towards the guideline of sustainable practice requires more access to loan. For farmers, partly from the industrial figures, "The government should support farmer cooperatives more, especially on loan." Fernando Malveda, President, LEADS Agricultural Products, told OBG "They have a lot of land but very little money for necessary factors of production." He added that the sufficient support may change the Philippines from net importer of agricultural products to net exporter. To support the request to increase funding, the report of the Mindanao of the Philippines disseminated by the World Bank in June last year identified the increased access to loan as the key to improve farmers' output on the 2nd largest island of the Philippines and necessary to accommodate the shift to crops with high return and high value. (IBEF, 2022)

2.8.2 Interesting Domestic Smart Farming Practices

Khun Ayu Chuepa or "Khun Li", owner of "Akha Ama Coffee" business, was awarded Young Smart Farmer 2016. He follows his dreams and wants to continue the royal duties of H.M. the late King Bhumibol Adulyadej. At first, coffee beans grown by villagers were highly underpriced. After study, Khun Li used knowledge to develop his hometown and educated villagers on coffee and build network of villagers to develop coffee varieties until the coffee jointly developed by villagers and Khun Li

won awards in the global arena three years in a row. Villagers could afford to send their children to school who returned and used their knowledge to develop their community. But the key was evidently marketing which required planning from beginning till the end. Khun Li paid attention to cultivation, packaging, and marketing via online system. It enabled the “Akha Ama Coffee” brand to succeed in a short time.



Figure 2.7 Khun Ayu Chuepa or “Khun Li” Owner of “Akha Ama Coffee” Brand

Note: Khun Ayu Chuepa Owner of “Akha Ama Coffee” Brand

Khun Piya, owner of Cherry Tomato Farm “Touch the Horizon” uses dripping technology combined with IoT (Internet of Thing) in his farm. It is considered safe agriculture as chemicals are used only during the period of sapling. The reason that Khun Piya chose to grow cherry tomatoes was because of its return. The yield would not be lost. If the yield did not pass quality inspection, it would be processed into other products. Moreover, the variety of tomato of the farm Touch the Horizon was developed into seedless cherry tomato. With the excellently developed variety, Khun Piya used the IoT technology to take care of the farm and could control and inspect various conditions in the farm with precision. As a result, the farm has become

Thailand's leading farm and the cherry tomato farm Touch the Horizon was selected as prototype farm in DTAC Precision Farming Project as well.



Figure 2.8 Khun Piya, Owner of Cherry Tomato Farm “Touch the Horizon”

Source: Bangkokbiznews (2020).

Khun Nan or Miss Waraporn Mongkolpaet, student with first-class honors from Chulanlongkorn University, built upon her family's mango farm until it became the “KhaoYai The Mango House Farm”. Upon graduation, she decided to develop her family's business from wholesale at Si Mum Mueang Market only to development of mango quality for export. Moreover, Khun Nan perceived the problem whereby some mangoes had unattractive skin but with delicious meat inside. The mangoes were therefore processed to increase value into mango ice cream, chilled mango in scented syrup, mango pudding, mango jam, and others in parallel with the creation of “KhaoYai The Mango House Farm” to present the developed product to the outsiders. It inspired others to know and focus on product quality and seek to control from upstream to downstream so that customers received the best products.

1) The growth rate of Thailand's agricultural sector is slow contrary to other manufacturing and service sectors. The value of the agricultural sector has

the share of only 10% of GDP. Most Thai farmers still practice traditional farming with focus on the use of labor force, dependence on the weather,



Figure 2.9 Khun Nan or Miss Waraporn Mongkolpaet, Owner of “KhaoYai the Mango House Farm” Brand

Note: Apiwat Khamsing Owner of “KhaoYai the Mango House Farm” Brand

Lack of planning and good management so that they face the problems of high production costs and low output prices. Based on the case studies abroad such as in US, New Zealand, and Japan, the researcher found that these countries have widely used digital technology in the agricultural sector to increase efficiency and reduce agricultural costs. For example, cereal yields in US are as high as 8,143 kg per hectare and New Zealand 8,384 kg per hectare which double the global average or Japan with the problems of the aging society applies robots and digital technology, resulting in rice yields of 700 – 800 kg/rai compared with Thailand of 400 – 500 kg/rai only.

2) Therefore, Thailand 4.0 policy focuses on the systematic promotion of farming including the selection of plants that suits the area and the increase of output per rai to upgrade Thai farmers to become Farmer 4.0 or Smart

Farmer. It promotes smart farming according to the royal initiative of H.M. the late King Rama 9 who supported farmers and entrepreneurs to use agricultural innovation that would increase output and develop Thailand's agricultural sector to be self-reliant, living comfortable but moderate lives, and finally escape from poverty. The EEC projects especially EECi and EECd will encourage cooperation among the public and the private sectors, as well as academic institutions and research institutes to develop and promote the use of various technologies to increase efficiency in agricultural production, as well as support Startup companies to participate in the development of Agri Tech, including software, hardware, database, and forecast systems which are less expensive than imported ones and suit Thai agriculture which will upgrade the competitiveness of the agricultural sector for further progress.

3) The ecosystem development of Smart Farming involves all sectors namely Private sector such as technology service providers such as agricultural robots, agricultural machine that connects with communication system, service providers of the IoT, Big Data, and Artificial Intelligence systems, service providers of wireless communication networks, software producers, etc. (2) The government who formulates the policy that influences the pricing of each agricultural product in each period and (3) Farmers who must change the mindset from reliance on the weather to the use of information for more decision-making and management.

4) The shift from the traditional farming to smart farming may be a great change of Thailand's social and cultural foundation. But the adaptation for "Produce a little but gain a lot" is inevitable in the age where global competitors turn to free trade, database, and investment in technology R&D to significantly upgrade competitiveness.

2.8.3 Smart Farming 10 Case Study

1) Chokanan Farm

Mr. Wonganan Sukcharoenkana, Hydroponics Vegetable Farm, Amphawa Subdistrict, Amphawa District, Samut Songkhram

With a Ph.d from Canada, "Wonganan Sukcharoenkana" is the owner of Chokanan Farm and pioneer of hydroponics vegetable farm for export to Europe. Mr. Wonganan graduated with B.A. degree in engineering, Kasetsart

University, M.A. degree in communication electricity from Colorado University at Boulder, USA, and Ph.D. in nanotech from Canada. He currently runs 2 businesses namely hydroponics vegetable farm, and processed sea food. The turning point in his career to pioneer a hydroponics vegetable farm is the trend of currently popular organic vegetables. Upon decision to practice organic farming, the first thing to do is to seriously undertake study, training, and study tours in the field, including cultivation methods, technology, and search for market or regular business partners. About 2 years ago, the crisis faced by exporters included insects and insecticide as farmers did not have closed greenhouse. So, he turned crisis into opportunity by running hydroponics vegetable business which were premium products in parallel with the search for market in view of support prior to investment in vegetable cultivation, the practice of which exporters respond to this business model.

Mr. Wonganan explained that the cultivation with the closed greenhouse system had high costs and could not sold in general markets. So, he looked at 2 markets namely modern trade markets, hotels, and export markets. Currently, he grows 11 types of vegetables such as kale, bog choy, Taiwanese bog choy, water convolvulus, coriander, celery, spring onion, Chinese cabbage, basil, sweet basil, etc. especially tropical vegetables that cannot be grown abroad. All types of vegetables are certified with the Global GAP standard so he can have access to premium markets and modern trade markets abroad. But certification of the Global GAP requires approximately 8 months and the expenses are quite high. He currently sends his products to 3 exporters in Switzerland, Germany, and England. In the future, he sets the target to become exporter himself as he has no factory of his own. “To drive Thailand’s farming to 4.0, Mr. Wonganan agrees that the first priority is to use technology and greenhouse. The government must make greenhouses cheaper. If farmers undertake the practice and the selling prices are the same, there is no need. The government must help by finding markets and the farmers must be certified with standards, at least GAP”. Wonganan Sukcharoenkana (person communication, 21 February 2021).

2) Melon & Salad Farm

Mr. Weerapong Su-osot, Khlong Jed Subdistrict, Khlong Luang District, Pathum Thani

Mr. Weerapong Su-osot, young smart farmer, the second generation of the owner of “Uncle Daeng’s Melon & Salad Farm, Khlong Jed Subdistrict, Khlong Luang District, Pathum Thani says that the other benefit of digging a pond around the area is that although with strong sunlight, it is not very hot because the surrounding water will reduce the farm temperature. At the same time, the pond will serve as the area division with cultivation of big trees or perennial plants for shade. Here, mulberry trees are planted as surrounding fence as they give fresh output for sale and processing.

The farm of Mr. Weerapong’s father started from rice cultivation and then shifted to growing of oranges, guavas, and other types of fruit trees. Until 2013 after graduation, he started to work in a company. But as he was interested in farming and he liked challenges, he experimented on cultivating melons in parallel with his regular job. At first, the cultivation was undertaken outdoor. The first cycle yielded abundant output. But in the following cycle, the insects started to cause trouble. Almost all output was damaged. So, he started to think of a greenhouse for cultivation. He had to rethink everything because cultivation in a greenhouse was different from outdoor especially for soil formula or fertilizer formula. He continued to study by himself until he acquired his own formulas. When everything was in order, 2 years ago, he resigned from work and became a full time farmer.

Khun Weerapong has a very interesting notion on the sacrifice of half of the land to dig a pond to use the water for the farm.

“Most of those who grow vegetables in the irrigated area ignore water because they think that they can draw water from the irrigated canal all year round. Digging a pond will always waste space. But they forget that sometimes there may be contaminants in the canal which may damage the vegetables. Sometimes, there is the surge of sea water. So, I decide to use half of the land from the total of 8 rai to dig a pond of 2-3 meters deep and 10-12 meters wide. The pond will surround the area in the form of the letter L to store water for my own use and for breeding of tens of thousands of fish. The pond has been dug for 4 years. And I never have to draw water from the outside to use in the farm.” Weerapong Su-osot (person communication, 19 February 2021).

3) Suanlungthod Banana Orchard

Mr. Theerapong Suksawang, 43 Moo 5, Nong Sam Wang Subdistrict, Nong Suea District, Pathum Thani

Mr. Theerapong Suksawang or Khun Tum residing at 43 Moo 5, Nong Sam Wang Subdistrict, Nong Suea District, Pathum Thani is a Young Smart Farmer who turns his interest to preserving rare and valuable banana varieties. Apart from spiritual value, the preservation of quaint banana varieties substantially generate supplementary income for Khun Tum. He graduated with M.A. degree in chemical engineering from Kasetsart University. After graduation, he had the opportunity to work in his field of education for 3-4 years. He had to resign from work to take care of his aged parents. The members of his family had the background in farming. His parents grew oranges. But after some time, the orange orchards in Pathum Thani faced crisis. Oranges died from disease. So, his family turned to grow and sell decorative plants such as temple tree, sealing wax palm as supporting trees instead. Until 2011, he and his parents turned their interests to quaint and rare banana varieties. It started with his neighbor.

Khun Tum started the conservation of unusual banana varieties from 2011 until the present. He collects over 170 varieties. Khun Tum says that the collected unusual banana varieties are mostly from the neighbor and additionally by himself. The difficulty in preserving the unusual banana varieties is not only the rarity but sometimes for the same banana variety it is called differently depending on provinces or regions. Sometimes, when he exchanges variety with someone who is not expert, he will get the same variety back or will be cheated. So, he recommends to buy at the known and trusted farm. The output from cultivation for cutting and selling of banana shoots takes only 6-7 months and 1 tree can be dug for sale with the output of approximately 5-8 shoots depending on the completeness of the shoot and the variety. For example, plantain has a lot of shoots with 2 rounds around the tree or approximately 20 shoots. But not all shoots are perfect. If any shoot is

imperfect, it will be cut off to keep the strong ones. Theerapong Suksawang (person communication, 19 February 2021).

4) Suanpanisara”

Ms. Panisara Thongsima 99/1, Moo 8, Nong Kai Subdistrict, Kratumban District, Samut Sakhon

Ms. Panisara Thongsima or Khun Petch is the owner of Suanpanisara. She is 42 years old and graduated with B.A. degree in Business Administration, General Management and Entrepreneurship Program, Siam University. After graduation, she started work in the marketing department at Mahachai 1 Hospital in Samut Sakhon and stayed there for 2 years. She returned to help her parents with their orchard. Her sister graduated from Suan Dusit Rajabhat University then got married and started a lemon farm on the area of 35-rai with her husband. As there are only 2 sisters, the orchard's burden fell on Khun Petch. In the past, grapes, mangos, dragon fruits, and lemons were grown and now are replaced by guavas, with the guava varieties of Golden, Kimju, and Red Kimju. The repeated cultivation of the same type of plants will reduce output. It is recommended to practice rotation. The guava tree is 4-5 years old. But if the chemical fertilizer is used, the tree will be only 3 years old. Khun Petch's method is semi farming between organic and chemical farming or bio farming, with focus on greatly reduced production costs, safety for growers and consumers, product safety, and not exclusively on organic farming. The context of the farm is not appropriate due to the location of the farm as adjacent farms all use chemical fertilizers. The solution is to try to reduce the use of chemicals by using bio and chemical fertilizers during the outbreak of worms and aphids by using 'bio fertilizer' instead of manure, stable manure, cow droppings, quail droppings, with focus on roaming cows instead of cows bred in the farm due to the contaminated hormones and food leavening agents in the cow droppings.

Suanpanisara has the total area of 24 rai from the former area of 20 rai. Khun Petch rents additional 4 rai of land for the experiment of integrated farming system. Dates are grown with bananas, mangoes, coconuts,

and rose apples instead of monoculture like in other orchards. It is rich in the ecosystem. It turns out to be effective. The date trees are not too high and tasty. The dates use seeding and not tissue culture due to high costs. Four years ago, it cost 1,500 baht. Nowadays, the price climbs to 2,500 baht. It takes 3 years after the seedling is grown in the soil. When the date trees start to have output, it will be kept frozen in the refrigerator in order to be dried for sale. It had been 5 years that she starts to grow dates. In the past year, she started to welcome tourists. Khun Petch receives knowledge from YouTube. The VDO is on pollination, and bending of the bough. Khun Petch's farm is at an advantage due to loose soil with many mixed minerals. In the past, the local people used to practice paddy farming. Later, they turn to grape orchard by ridging similarly to exposing the soil in the sun so that the upper soil is dry and loose which is suitable for cultivation due to the presence of minerals. As for the water, it will flow down to the ditch. The use of bio fertilizer only from roaming cow droppings will help maintain rich soil. For the business of Khun Petch's orchard, the main players are Khun Petch herself and her mother. Her father is very advanced in age and no longer helps in the orchard. There are also 2 temporary workers. Panisara Thongsima (person communication, 19 February 2021).

5) Pitak Mushroom Farm"

Mr. Pairoj U-pitak, 45 Moo 5, Tha khai Subdistrict, Mueang Chachoengsao District, Chachoengsao

From engineer to farmer: From an engineer working in industrial plants until one day his company started to have business problems so he did not have to go in everyday only some days as fixed by the company but he still received salary. At that time, he started to look for work elsewhere. Finally, he opted for mushroom cultivation with many trials and errors. During the first 5 years, it was the struggling period because the money was heavily invested but there was no return and there were many problems, nearly bankruptcy. But problems required solutions. Although one problem was solved, another one arose. He had to solve problems all the time but he never

gave up. After 5 years, everything started to stabilize. The cultured mushroom started to yield return. The company that Mr. Pairoj worked with started to be more secure. Everything returned to normal. But Mr. Pairoj decided to practice mushroom farming full time. Afterwards, Pitak Mushroom Farm started to be more secure. Mr. Pairoj practiced mushroom culture and made spawn himself. The return included mushroom, and spawn culture, as well as mushroom processing. Moreover, when the spawn started to expire, it would be used as fertilizer. He could also grow lemons for sale. It can be said that today Mr. Pairoj transforms everything in the mushroom farm into money. Mr. Pairoj's knowledge on mushroom cultivation is acquired from learning online, learning from District Agricultural Extension Office, additional learning at Chiang Mai University once a year until the lecturers trust him to represent them by providing knowledge to the residents in Chachoengsao and adjacent areas. His success derives from his serious learning, real implementation, testing by himself which result in direct experience that is better than learning in classroom only. Pairoj U-pitak (person communication, 5 February 2021).

6) Rice berry rice

Mr. Chaisri Loonlertpol, 26 Moo 1, Mahasawat Subdistrict, Phutthamonthon District, Nakhon Pathom

After graduating from the third year of secondary education, he joined the Smart Farmer Project between 2015-2018. He was the model farmer in the field of production of organic rice. He became farmer following his parents' footsteps. As his father was old, he assigned all 6 of his children to bear the responsibility instead. Khun Chaisri was the youngest son. During his time, his father practiced only rice farming. But Khun Chaisri practices integrated farming. In the past, the only practice of rice farming was relatively complicated. He started by growing the *Khiew Sawoey mango*. After some time, he found out about the problem that with the mangoes grown on the garden plot, its roots would find food with difficulty. They were not grown like in a farm or in a general mango orchard. They also yielded a small amount

of output. The age of the *Khiew Sawoey* mango with the maximum harvested output was approximately ten years. After consulting with his wife, he decided to cut down all the mango trees and turned to rice farming. The rice variety was Gai Tawng Kum rice. Usually farmers grow it by using the tractor to plow paddy rice provided by local investors. The investors will bring the rice variety for free and at the same time provide the tractor free of charge as well. Once the output comes out as unhusked rice, the investors will buy it back. Khun Chaisri takes care of his paddy plots by himself. The high or low return of the output will depend on care and dedication. The output will be higher than rice from paddy-sown field. Because for the field where the seeding rice is transplanted, the investors will select and provide the rice variety that yields high output. After a while, when the tractor owners suspend operation, Khun Chaisri cannot continue by himself due to old age so he turns to riceberry rice farming.

Apart from the successful cultivation of riceberry rice, Khun Chaisri practices additional integrated farming on the area of 3 rai by cultivating Kimju guava and aromatic coconut. He will take the output to the market to sell. Nakhon Pathom Provincial Office provides the space for farmers in Silpakorn University every Wednesday and Friday. For every Saturday and Sunday, they will sell them at the Ban Sala Din floating market. The rest of the week namely every Monday, Tuesday, and Thursday, Khun Chaisri and his wife will spend their time in the farm taking care of the output and preparing the goods for sale the following day.

His advice to those interested in growing riceberry rice is to consider land as the first priority. What kind of crop was formerly grown on the land or if the soil is newly cleared. The riceberry rice uses the rice seed for only 10 kg a rai due to its light weight. The appropriate timing cultivation is to start on 1 July and 20 November in order to acquire output with good quality. Chaisri Loonlertpol (person communication, 19 July 2022).

7) Pomelo Orchard

Mr. Uttapol Polachai, 9/1, Moo 4, Bang Toei Subdistrict, Sampran District, Nakhon Pathom

Mr. Uttapol graduated with a B.A. degree from Srinakharinwirot University and participated in the Smart Farmer project between 2016-2018. Khun Uttapol became the third generation farmer following his ancestors. His family had tilled the same land of 16 rai for over 100 years. He started life like the son of any other farmers in the area. His parents sent him to school. He graduated with a B.A. degree and worked in his academic line. He lived in Bangkok to look for experience for 5-6 years. When he was saturated, he moved back to his hometown in 2011 which was the year of the great flood in Thailand, especially in Bangkok Metropolitan Region.

The generation of Mr. Uttapol's father traditionally grew rice although the land in the central plains is more suitable to grow fruits. In the past, it did not require large capital contrary to the present day when costs are rather high. Between 1987-2002, it was the golden age of fruit orchards. But from 2007 until the present, it was the downtrend. The same is for rice cultivation due to high costs. As for the costs of living and the attitude when farmers earn more income, they will send their children to have higher education. Thus, the problems of the shortage of labor occur. So, they have to change their mindset and plan more. But plan alone cannot move forward. So, they have to return to the old agricultural practice of their father's generation. But waiting for labor force or the weather alone will be difficult to succeed. They have to plan and implement at the same time and they also need imagination.

After the floods, all fruits in the orchard died. He had to start afresh. The application of the Smart Farming was for survival. He had to do anything to reduce costs, develop himself, apply technology, collect data on the weather, and prepare the income-expenditure account.

The output in Khun Uttapol's farm was also affected by the epidemic because he relied on export. The farmer's initial investment was 45% but at present is 50%. The other part is local merchants who come to take them for

sale. Once the prices are reached, the merchants will come to harvest the output themselves. Except for pomelo, the owner must collect them himself. The pomelo varieties include Siam Red Ruby, and White Honey. As for betel nuts, the local workers come to harvest them. Uttapol Polachai (person communication, 19 July 2022).

8) Integrated Agricultural Garden

Mr. Suriya Choowong, 21 Moo 2, Tham Rong Subdistrict, Ban Lat District, Phetchaburi 7610

Mr. Suriya's father was originally from Ban Lat and mother from Tha Yang and moved from Tha Yang to reside on the current land of 16 rai. He started farmer profession since he was 12 years old, mostly monoculture. When he was 26 years old, he had the opportunity to have audience with His Majesty the Late King Bhumibol Adulyadej the Great who talked about the Sufficiency Economy as follows: 1. Moderation 2. Reasonableness 3. Self-immunity. Mr. Suriya used the Sufficiency Economy Philosophy as a guideline to practice farmer profession. He started by growing many fruit trees such as palmyra palm, green rose apple, Cavendish banana, aromatic coconut, durian, papaya, sapodilla. He grew them in an integrated and rotating method. The output would yield on a continuous basis and alternately all year round. As for Cavendish banana, Mr. Suriya had experience in cultivation by planning in advance the output to come out at the same time as the high demand of the market. The farmers' costs to grow Cavendish banana in 1 rai or 400 trees required the investment capital of approximately 16,000 baht, profit of approximately 30,000 baht, and cultivation time of approximately 7-8 months. He started the cultivation approximately between May-June to have output for sales during the Chinese New Year to get good prices. Mr. Suriya made sacrifice by not growing Cavendish banana so as not to compete with other members of the farmer groups and turned to grow other types of bananas instead such as dainty banana, lady finger banana.

Uncle Noi follows the Sufficiency Economy Philosophy for the past 35 years. He stresses sufficiency, moderation, and self-reliance. He uses

reason in living and profession. He records household account, farm account, and the agricultural information to analyze production planning. With creativity, and sacrifice, he serves as volunteer to transfer knowledge and experience on agriculture to interested people. Real practice is conducted in the area of 16 rai with integrated farming of paddy farming and cultivation of non-toxic fruits such as rose apple, sapodilla, lemon, papaya, Marian plum, Gros Michel banana, dainty banana, Ducasse banana, palmyra palm, etc., which are certified with the G.A.P. standard for plants. He produces bio fertilizer, bioextract, and insect trap used in the field to reduce production costs. The output is certified with the agricultural product and food standard or the Q logo to ensure consumers' confidence in terms of food safety and quality. He plans production, marketing, and searches for ways to reduce production costs, takes precaution in the profession, and systematically plans the family expense. He also practices time management, works for the common good and the community. He is a role model in living life and recognized by people in the community. Suriya Choowong (person communication, 19 July 2022).

9) Pin-Chai Date Orchard

Mr. Chatchai and Mrs. Tepin Saengcharoen, 13/1, Moo 3, Nang Kaeo Subdistrict, Photharam District, Ratchaburi

They are a married couple who turn to practice farming profession in their hometown. After graduating with B.A. degrees, they went to work in Bangkok. In 2002, Mr. Chatchai moved back to his hometown to practice agriculture just like his ancestors. But he did not like to grow paddy like his parents due to frequent problems in terms of low prices. So, he started by growing sweet bamboo and selling the shoots, rotating crops, annual crops, eggplant, cow-pea, gourd, bitter gourd, bottle gourd on the land of 5 rai. The middleman would come to take them for sale instead of growing paddy like other local farmers

In 2015, Mr. Chatchai went for a study tour of date cultivation in Kanchanaburi. The BAHE strain was the best strain of Iraq. The tissue would be spun and cultured in a nursery in England for about 1-2 years. Usually, 25

trees were planted for the area of 1 rai. Khun Chatchai studied the details of the strain, insects, and pests until he had clear understanding before he decided to plan to start the investment. In 2017, upon the detailed study of the qualifications of dates both strong and weak points, Mr. Chatchai and Mrs. Tepin decided to invest in date cultivation. They bought date trees for 1,600 baht per tree for 100 trees with the total investment of 160,000 baht. Presently, there are in total 114 trees on the land of 5 rai. Chatchai Saengcharoen ;Tepin Saengcharoen (person communication, 19 July 2022).

10) Bangkachao Farm

Mr. Thaweesak Ong-Eiam, Soi Phetcha Hueng 21, Bang Yo Subdistrict, Phra Pradaeng District, Samut Prakan

Mr. Thaweesak has 6 siblings. He is the fifth son. After graduating with a B.A. degree from Faculty of Business Administration, Ramkhamhaeng University in 1994, he started work in Bangkok, got married, and had 2 children until 2016 when he decided to move back to Bangkachao because he had the problems of having to take his children to school every day and bring them back home. With his wife, he decided to build a house and start growing chili, and lemon. But the output was not very good. If he returned to practice farming just like his mother, it would not be successful because everything changed. So, he started a Western-style greenhouse to grow vegetables with the Aquaponics method by growing them in water and with plastic tubs in the greenhouse. At that time, the Hydroponics method was popular but he was not interested and tried to avoid as the cultivation required chemicals.

In 2017, Mr. Thaweesak started growing vegetables with the Aquaponics method. It was cultivation in the water. Below Mr. Thaweesak bred snakeskin gourami whereas the vegetables were above. For the first round, the output was very good. But for the second round, everything was damaged. Because when the fish started to become bigger, the excretion was greater. The water became polluted. There were a lot of bacteria clinging to the roots, knotting and rotting the roots. The vegetables all died. He had to find other sources of knowledge to continue with his farmer profession.

In 2018, Mr. Thaweesak had the opportunity to study worm breeding with Acharn Somchai Chansawang who gave free lecture at Kasetsart University. After the study, Mr. Thaweesak started to undertake worm breeding at home. The main objective was to use it as fertilizer to reduce costs for the cultivation of vegetables. The main cost for worm breeding was the purchase of coconut dust which was minced coconut scraps approximately 80-100 baht a sack as main raw material for the breeding. Until he met an older friend who had a termite mushroom farm for export to Japan. He started to take interest and started a mushroom house that could keep humidity. At the first experiment, from 10 mushroom pieces, they presently increase to 20,000 mushroom pieces, at 25 baht a piece. The damaged or the expired piece will be used to feed the worm instead of coconut dust with the kind assistance from the friend's farm. When the mushroom pieces are to be disposed, he will ask his workers to go and fetch them and use them instead of minced coconut for worm breeding. The other main cost is cow dung.

The worm was formerly bred in plastic bucket. He restarted the experiment by improving the breeding on the plot with vegetables above and worm below. The water used to water the vegetables above would flow down the worm that was bred beneath so it automatically received humidity without wasting time to water the worm any longer. The water, time, and energy were effectively saved.

In 2019, Mr. Thaweesak was supported by Department of Livestock Development to experiment the breeding of ducks and chicken until he was highly successful. They are fed by vegetable scraps from the trimming of the farm output for attractiveness before being sold. Instead of throwing away these vegetable scraps as waste, they were used as food for ducks, and chicken and received in return duck and chicken eggs. The duck and chicken droppings would be composted as fertilizer

Mr. Thaweesak's Bangkachao Farm is the only farm in the province certified with the standard of Organics Thailand. At present, it cooperates with Sampran model to act as a coach to set up organic farming groups by grouping local farmers to start organic farming with 3 batches, and 30 farmers

called “Kung Bangkachao Organic Farming.” The members have good understanding of Smart Farming and use the IOT in their work. Watering is controlled by the Smart Phone. The groups run a project based on the MOU with PTT on Smart Farming and on fertilizer made from waste. Moreover, other agencies both public and private participate in numerous activities with the farm such as Kasetsart University, National Research Council of Thailand, Central Department Store, Munkong Kehakarn, Suan Sampran, the market where the groups’ products are on sale at Bangnamphung Floating Market, Healthcare center, Bumrungrad Hospital in cooperation with Munkong Kehakarn. As for the output, apart from salad they were mainly mushrooms, duck and chicken eggs. Thaweesak Ong-Eiam (person communication, 19 August 2022).

2.9 Relevant Research Works

2.9.1 Smart Agriculture and Sustainability

Smart agriculture is an agricultural system that uses new technologies and innovations to increase efficiency in the production process. by focusing on the efficient use of natural resources reduce the use of chemicals And reduce soil degradation. In addition, smart agriculture can generate higher income and increase sustainability for farmers and communities as well. The development of smart agriculture is very important in the context of climate change which is a major factor affecting agriculture. The use of geospatial technologies such as the use of industrial data acquisition systems. Using drones to collect data Application of IoT (Internet of Things) technology in agriculture Make it easier for farmers to take care of their plots. Reduce production risks and increase productivity in the long term (Cheema et al., 2022). In addition, smart agriculture can reduce the use of chemicals in growing crops. Reduce soil degradation and increase the value of production. It increases income for farmers and helps to strengthen the community's economy. With the deployment of smart agriculture technology to create sustainability in crop and animal production, Internet of Thing (IoT), big data (Big Data), Artificial Intelligence (AI) and precision agriculture technologies are applied. Used to develop sustainable crop

production systems and prevent the use of chemicals in agriculture. The use of these technologies in smart agriculture will increase the efficiency of crop production. Reduce the risk of plant disease And reduce the use of chemicals in agriculture more efficiently. It also reduces the use of water and energy in crop production. Building and developing a data collection and data processing system to increase the efficiency of agricultural plot management. Decision support system (Bersani, Ouammi, Sacile, & Zero, 2020) has been developed for smart agriculture using aircraft models. that uses aerial data to bid for data and predict future weather conditions This enables farmers to make informed decisions about the selection of modern, correct methods of growing crops, water management and fertilization. which improves the efficiency of growing crops to calculate the risk of plant disease and water consumption. The production process saves resources and reduces the use of agricultural chemicals (GS Campos, Rocha, Gondim, Coelho da Silva, & Gomes, 2019). Development of agricultural technology to reduce the use of chemicals and increase productivity in the long term. Smart agriculture is very important in terms of sustainability. Especially now that farmers want to increase productivity in the land that is limited. But it also needs to focus on the sustainability of the use of the world's available resources. It can produce more productivity without causing damage to natural resources and the environment. can be reused. It also reduces the amount of waste and the use of agricultural chemicals that have a negative impact on the environment and human health. In addition, smart agriculture allows farmers to track and analyze production data in detail. and improve the production process to obtain high quality output. It can use automation technology and internet connection with the Internet of Thing system to increase the efficiency and accuracy of planting and harvest management. Help reduce production costs and increase income for farmers. There is a reduction in the use of water and energy in agricultural food production. It is an efficient use of water and energy. which is an important factor in the development of sustainable smart agriculture. And can also reduce the impact on the environment (Lioutas & Charatsari, 2020). Using automation technology to increase efficiency in agriculture to improve long-term sustainability is focused on robotic harvesting. product Using IoT devices to monitor and control the growth of plants and livestock and automatic animal husbandry Smart agriculture can also be sustainable and increase productivity

in the long term. There are also advantages of using technology to help reduce costs. reduce the use of chemicals Reduce toxic emissions in the environment As well as increasing productivity and quality of produce, technology is therefore essential in adapting farmers to environmental changes for future sustainability. including vertical farming With advanced precision monitoring and control with Internet of Things (IoT) technology, urban smart farming meets economic, social and educational needs (Oh & Lu, 2023).

2.9.2 Smart Agriculture and Environmental Impacts

Farming in general is an activity that is intimate with the environment and has varying degrees of impact on the environment, from the use of chemical fertilizers. Use of chemicals to prevent and eliminate pests water use in agriculture Management when there is a natural disaster, for example, the use of chemical fertilizers and chemicals to prevent and eliminate pests may have an impact on the environment, such as chemicals that are toxic to aquatic animals and plants. May have implications for human health. when consuming produce with chemical residues Water use in agriculture is an important factor in the production process. If an excessive amount of water is used It can affect the water supply in the area and affect the environment as a whole. Rodriguez, Guzmán, Sánchez-Molina, and Rodriguez (2020) can eventually cause water scarcity. Instead, smart agriculture is an environmentally friendly farming process using technology and innovation to increase efficiency and reduce risks in agriculture by using geospatial information (GIS) to analyze climate and land changes. Real-time signaling technology to control the use of water and the use of chemicals to prevent and eliminate pests and plant diseases in each area Zhao, Di, and Sun (2022), which reduces the problem of water use in agriculture. And reduce the use of chemicals in growing crops, which reduces the impact on the environment. In addition, the use of smart agriculture technology can help reduce energy consumption in traveling and transporting produce. By using technology to collect and process data, such as using autonomous trucks or using drones to sow crops. Pesticide injection, fertilization, which results in lower energy consumption and reduction of greenhouse gas emissions in such activities (Mattivi et al., 2021). In addition, smart agriculture also uses technology to reduce the use of chemicals in agriculture.

Reducing the use of chemicals in growing plants, especially the use of chemicals to prevent and eliminate pests especially the use of chemicals to eliminate insects, fungi and weeds in corn cultivation by using natural methods to prevent and eliminate pests by using the method of planting green areas. mixed planting seasonal cropping Use of plants that are resistant to diseases and insects. use of biologics and use of technology to increase the efficiency of organic farming for example, using the Internet of Thing system to help measure soil conditions, temperature, water levels, Ramachandran et al. (2022), in addition, agricultural technology is used to reduce climate change. Climate change affects food production and cooking around the world. have implications for food security and future population nutrition. Especially in the part of farmers and people living in rural areas and risky areas. will be affected the most. Great management of the use of natural resources. Increasing the flexibility of food production processes Using the right technology in the production process of smart agriculture can help reduce the impact of climate change. The success of these projects depends on cooperation between different parts of the global food production and consumption network of agricultural products (Steenwerth et al., 2014). develop sustainable agriculture It focuses on the link between energy and agriculture. This is a new concept that has emerged in recent years. The relationship between energy use and agriculture is analyzed. and support the development of highly efficient agriculture by using renewable and environmentally friendly technologies, such as the use of solar energy in organic farming. and using technology to connect to the Internet of Thing system to increase efficiency in agriculture Emphasis on the concept of sustainable development of the use of renewable energy in agriculture. which can promote efficient harvesting and reduce energy peaks in agriculture for sustainable agricultural development (Raihan & Tuspekova, 2022).

2.9.3 Smart Agriculture and Quality of Life

Using technology and innovation to develop and improve the agricultural system to increase the efficiency of the production process in order to maximize the yield while reducing the use of chemicals that are harmful to the environment and human health, increases the quality of life of farmers and the communities living in them. In an area that has a lot of agriculture. It is a connection between agriculture

and technology and the Internet of Thing system together. to increase security and income for farmers (Srivetbodee & Igel, 2021). It can also reduce the loss of crops and reduce disease outbreaks caused by the use of agricultural chemicals. Technology development to enhance the quality of life for farmers For example, using the Internet of Thing to manage smart greenhouses (Rayhana, Xiao, & Liu, 2020). In the production of crops, the use of data analysis technology. to analyze temperature, humidity, light, wind movement Including the introduction of an AI system to help manage decisions and improve the quality of cultivation and production, the development of an IoT system for controlling water quality in agriculture. with the use of Sensor technology Measure salinity and lead content in water to improve agriculture and increase water use efficiency in agriculture. This system can accurately measure the salinity and lead content in the water and can report the results to farmers via smart phones, which help farmers improve agriculture efficiently and reduce water use in agriculture. Unnecessary can be reduced. Lichun et al. (2022) Development of environmentally friendly agricultural management and production for quality of life, such as

To sustainably increase crop yield and soil resilience. improving agricultural productivity Along with conserving and increasing biological resources and living things. is what is needed to increase global food production on a sustainable basis. The role of farmers in increasing agricultural productivity for sustainable growth is of paramount importance. Smart agriculture can be central to starting any transformation process. related to natural resources The relevant government and corporate bodies are encouraged to provide appropriate support and good governance practices. to conserve natural ecosystems and biodiversity and reducing the negative impact that agriculture can have on the environment. Farmers and stakeholders need to revise traditional practices that are not as effective as modern agricultural practices. But it is more friendly to the values of natural ecosystems and the environment. as well as emerging new tools and approaches to dealing with precision farming. Organic Remedies Reduce Water Consumption Integrated Pest Control and beneficial plants microbial interactions While practical solutions are evolving Crop rotation, breeding, and harvest/post-harvest strategies leading to greener production. and better quality of life for smart farmers Schröder et al. (2019) In addition, climate change. Rising

temperatures and carbon dioxide levels in the atmosphere. It is a serious threat to the environment and all living things. especially A number of studies have pointed to a strong effect on the vigor of farmed crops. This affects both the productivity and the quality of raw materials sent to the food industry. Of particular concern is the decline in protein and essential micronutrients such as iron and zinc in crop yields. environmental impact reduction from the use of pesticides Nitrogen and Phosphorus Leaching soil erosion Reduction of water and contamination and improving raw materials and food quality Organic farming, bio-fertilizers and, to a lesser extent, nano-carriers can improve the antioxidant properties of the crop. Advanced equipment and precision farming make farming more profitable. efficient It contributes to the reduction of pest diseases and increases the quality of agricultural produce and food safety. Therefore, today, the application of technology to sustainable farming systems is a constant challenge in the face of negative trends. Due to the impact on the environment and climate change, Caterina Agrimonti, Marta Lauro (2020) and the smart farming process, precision agriculture, can also help manage crop inputs. in an environmentally friendly way Target rates for fertilizers, seeds and chemicals can be set for soil and other conditions. For the long-term sustainability of agriculture to reduce the environmental burden by using fertilizers and pesticides only when and where needed. Precise agricultural benefits to the environment come from more targeted use of production inputs. This reduces losses from overuse and from reductions in losses due to nutrient imbalances. ability to eliminate weeds and eradication of insects, etc., as well as decrease the development of resistance to pesticides (Bongiovanni & Lowenberg-DeBoer, 2004).

2.9.4 Smart Agriculture and Circular Economy

Smart agriculture is an agricultural process that uses technology and innovation to develop agriculture to increase productivity. Reduce costs and reduce the use of natural resources to achieve more efficient agriculture. In addition, smart agriculture also emphasizes the use of technology, Internet of Thing (IoT) systems to help with work. reduce the use of chemicals reduce greenhouse gas emissions The agricultural sector is one of the economic sectors that affects climate change, directly and indirectly contributing to greenhouse gas emissions. There is a trend of reducing

agricultural greenhouse gas emissions. But any practice in this direction should not negatively affect the productivity and economy of the farm. Because this will limit the operation. Due to the high global demand for food and productivity. Including the environment of competition in the agricultural sector itself. Precision agricultural practices using information devices are capable of reducing agricultural inputs by using specific target areas Balafoutis, Evert, and Fountas (2020), as it better targets inputs for spatial needs. and in terms of the duration of the work of farmers This may result in fewer greenhouse gas emissions. Precision farming also has a positive effect on farm productivity and economy. Due to high or equal yields with lower production costs than conventional farming. Precision farming technologies with the potential to reduce greenhouse gas emissions are presented and their respective impacts on greenhouse gas reductions and their associated impacts on farm productivity and economy. The proposed technology covers all agricultural practices. including sowing/variable planting, fertilizing, spraying, weeding and watering in the field Smart farming, which uses smart farming tools and smart processing methods based on the concept of circular economy, to reduce the impact of agricultural activities on climate change. Circular farming and precision farming in combination with the use of appropriate crop management tools can contribute to better resource utilization and sustainable farming practices (Benos et al., 2021). Sustainability focuses on using renewable energy. The production and use of biogas can represent a win-win strategy. That helps to reduce greenhouse gas emissions is a responsibility for climate change. while providing a number of significant social, environmental and economic benefits. The sustainability of biogas needs to be carefully assessed and continuously monitored, taking into account the economic, social context and timing of its implementation. Emphasis is placed on the environmental dimensions of sustainability (Pirelli et al., 2021). and there is now an urgent need to address the problems of agricultural processes such as the use of harmful pesticides. Irrigation Control Pollution control and environmental impacts in agricultural occupation. Smart farming has been proven to increase soil productivity and increase soil fertility. It uses various smart systems practices such as IoT, wireless communication, machine learning and artificial intelligence, deep learning (Jha, Doshi, Patel, & Shah, 2019), as well as the integration of renewable energy to promote energy-efficient agriculture. by

reducing dependence on fossil fuels for pumping water from water sources and intelligent irrigation to promote good crop quality and quantity without damaging soil and water ecosystems (Bouali, Abid, Boufounas, Hamed, & Benhaddou, 2021). systematically increases the value, quality and safety of produce Using sensors to measure soil and weather conditions appropriate water management system Using satellite images to track plant growth Using Artificial Intelligence (AI) to help analyze and make agricultural management decisions over time. It is a new concept that emphasizes the use of natural resources more efficiently as a system of production and consumption within the framework of reducing the use of natural resources and reducing the amount of waste by designing products and services for maximum life span. And make efficient use of natural resources. In addition, materials and items of lower value are used to reduce resource consumption and waste, including reusing or recycling waste, which results in an increase in efficiency. Use of natural resources and reduce changes in conditions reduce waste generation Reduce the use of chemicals in growing crops. Emphasis on organic farming methods The use of renewable energy and reducing pollution, as well as reducing the cost of production by focusing on maximizing the benefits of existing natural resources in the economy, are the links between sustainability (Martinho & Domingues, 2021).

CHAPTER 3

METHODOLOGY

3.1 Conceptual Framework

This study aimed to investigate the Smart Farmer agricultural practice in urban community towards the Circular Economy. Analysis was conducted on the key success factors of Smart Farmer agricultural practice. The model of sustainable Smart Farmer agricultural practice in urban community was recommended through the in-depth interviews with entrepreneurs who were Smart Farmers, experts, and relevant agencies by using the conceptual framework of the model of Smart Farmer for further learning and dissemination. The conceptual framework of the study is shown in Figure 3.1.

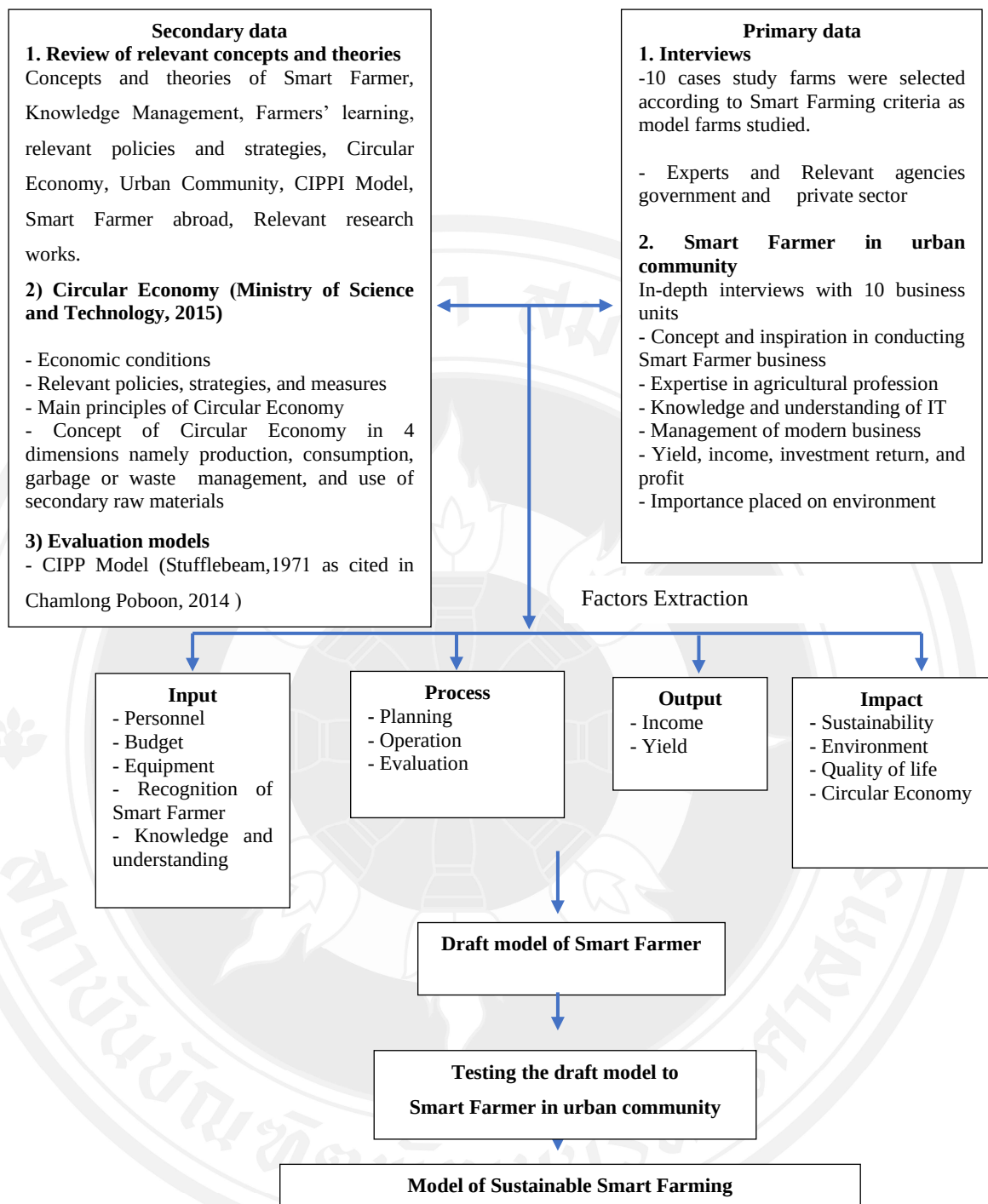


Figure 3.1 Framework for the Study of the Model of Smart Farming in Urban Community Using the CIPP-I Model

Table 3.1 Definitions

Main issues	Minor issues	Definitions	Interview questions
Input	Employees	Employees of Smart Farmer agricultural practice in urban community	How much do employees possess knowledge and understanding of Smart Farmer agricultural practice?
	Budget	Budget for Smart Farmer agricultural practice in urban community	Is budget for Smart Farmer agricultural practice in urban community sufficient?
	Equipment	Equipment and tools for Smart Farm agricultural practice in urban community	Are equipment and tools for Smart Farm agricultural practice in urban community sufficient?
	Knowledge of Smart Farmer	Perception of Smart Farmer from learning and practice that can actually be implemented	Do entrepreneurs have perception of Smart Farmer from learning and practice that can actually be implemented in the entrepreneurs' own farms? How?
Process	Knowledge and understanding	Knowledge and understanding of Smart Farmer agricultural practice in urban community	Do entrepreneurs possess knowledge and understanding of Smart Farmer in urban community and can transfer knowledge and understanding to interested people?
	Planning	How are process and management of Smart Farmer agricultural practice in urban community conducted? When? For whom? And who is responsible?	What is the process of Smart Farmer agricultural practice in urban community?
	Operation	Implementation or activities of Smart Farmer agricultural practice in urban community according to processes with the model that is appropriate to the environment in urban community	Are there processes of implementation of Smart Farmer agricultural practice in urban community? How? Are they appropriate to the environment in urban community? How?
	Evaluation	Evaluation if Smart Farmer agricultural practice in urban community goes according to plan. Are there progress,	Is there follow-up of Smart Farmer agricultural practice in urban community? Is there

Main issues	Minor issues	Definitions	Interview questions
		problems, and obstacles?	evaluation? How?
Output	Income	Income from Smart Farmer agricultural practice in urban community	What is the income from Smart Farmer agricultural practice in urban community?
	Yield	Output from Smart Farmer agricultural practice in urban community	What is the output from Smart Farmer agricultural practice in urban community?
Impact	Sustainability	Sustainability of Smart Farmer agricultural practice in urban community is systematically used and results in balance of human, economic, social, resource, and environmental cycles	Is there environmental management for Smart Farmer agricultural practice in urban community without destroying the human, economic, social, resource, and environmental cycles?
	Environment	Impact on ecosystem, air, water, noise, and waste from Smart Farmer agricultural practice in urban community	Does Smart Farmer agricultural practice in urban community have impact on ecosystem, air, water, noise, and waste? How?
	Quality of life	Good quality of life derived from Smart Farmer agricultural practice in urban community	Is there management of good quality of life from Smart Farmer agricultural practice in urban community? How?
	Circular Economy	Reprocessing and reuse of used resources focus on the use of resources for maximum efficiency to solve the problems of excessive use of resources than necessary	Does Smart Farmer agricultural practice in urban community lead to the Circular Economy in the community? How?

3.2 Target Groups

The selection of the target groups for the model of Smart Farming in urban community was conducted according to the six basic qualifications of Smart farmer (Smart Farm (Thailand), 2015) as follows:

- 1) Knowledge in own field, ability to serve as lecturer for agricultural technology transfer or give advice to those who were interested in the current field

2) Have information for decision-making, gain access to information from government agencies and via IT system and other communication channels such as Internet, Mobile smart phone, etc.

3) Output and marketing management, ability for management of factors of production, workforce, and capital, ability to link production and marketing in order to sell output, as well as ability for Zero waste management

4) Awareness of the quality of products and safety of consumers, knowledge or training attendance on the standard of GAP/GMP on organic farming or other standards

5) Environmental/social responsibilities, production process without causing pollution or destroying the environment, continuous CSR activities

6) Pride in being farmer, determination to practice farming, love and cherish the area and the agricultural profession for the next generation, happy and satisfied with the practice of the agricultural profession

Ten studied areas in the pilot farms included the following: (1) Hydroponics Vegetable Farm (2) Uncle Daeng's Melon & Salad Farm (3) Suanlungthod (4) Suanpanisara (5) Pitak Mushroom Farm (6) Lertphol Riceberry (7) Pomelo Orchard (8) Integrated Agricultural Garden (9) Date Orchard, and (10) Bangkachao Farm.

Table 3.2 Research Areas in the Prototype Farms in Ten Areas

Rank	Case studies	Type of Farm	Reasons for selection
1.	Hydroponics Vegetable Farm	Modern Farming	It is a large, safe hydroponics farm and certified with the Global G.A.P. standard, pioneer of hydroponics vegetable farm with export to Europe, and encourages Thai farmers to become farmers 4.0 through the combined use of technology.
2.	Uncle Daeng's Melon & Salad Farm	Modern Farming	It is the farm with water management and allocates half of the agricultural land by digging a pond and water management as Smart Farmer,

Rank	Case studies	Type of Farm	Reasons for selection
			supported by Hydro-Informatics Institute (Public Organization)
3.	Suanlungthod	Organic farming	Farmer who breeds over 180 varieties of Thailand's bananas with unusual or rare varieties and near extinction.
4.	Suanpanisara	Agroforestry	As part of Young Smart Farmer in Samut Sakhon and selected as the example of YSF in the book Young Smart Farmer Thailand in 2017 with the concept of integrated farming from the upstream with the safe production process of vegetables, the midstream with the processing of agricultural yields, and the downstream with the marketing both direct and through representative. It is integrated vegetable orchard with systematic ecosystem within the fruit orchard., systematic use of agricultural technology with microbial pesticide to get rid of pests, focus on safe production of agricultural products, and delivery to consumers with fair prices, and enhancement on the processing of goods for longer shelf life.
5.	Pitak Mushroom Farm	Modern Farming	It is a self-relying farm with production of mushroom spawn, steaming machine for mushroom spawn, Beauveria bassiana to prevent insects which reduced costs and increased productivity. The farm is also opened as a learning center for those who were interested.

Rank	Case studies	Type of Farm	Reasons for selection
6.	Lertphol Riceberry	Rice bare farming system	The interesting Smart Farming concept is environment. According to Khun Chaisri, what we get from nature, we have to give back. For example, for riceberry rice, there is no burning and no taking out. After harvest, Khun Chaisri will leave the straw in the field without burning it but leave it to degrade into fertilizer while waiting for rice cultivation in the next cycle.
7.	Pomelo Orchard	Organic farming	Smart Farming in Khun Uttapol's opinion and working guideline is to change the concept of farmers to work in accordance with the current demands of 2 generations of the old and the new ones.
8.	Integrated Agricultural Garden	Integrated farming system	Practitioner of the Sufficiency Economy Philosophy for the past 37 years in parallel with household account, farm account, and recording of the agricultural information to analyze the production planning under the promotion and recommendation of Cooperative Auditing Department. As a result, farmers are spared from the marketing mechanism and live happy lives without debt.

Rank	Case studies	Type of Farm	Reasons for selection
9.	Pin-Chai Date Orchard	Perennial crop based farming system	In 2018, Khun Tepin participated in the Smart Farmer project with Photharam Agricultural Office, Ratchaburi and used the knowledge to improve and develop agriculture jointly with Khun Chatchai in integrated farming with higher yield due to work planning, recording, and income-expenditure accounting. Currently, local farmers grouped themselves to grow dates on the area of about 20 rai and the output started to enter the market.
10.	Bangkachao Farm	Agroforestry	Khun Thaweesak's Bangkachao Farm is the only one in the province to be certified with the Organics Thailand standard. Presently, he cooperates with the Sampran Model to act as a coach to set up organic farm groups by grouping the local farmers to start organic farming in 3 batches, 30 farmers in each batch called “ Khung Bangkachao Organic Farming” . The members have good understanding of Smart Farming, and apply IOT in their work. Watering is controlled by Smart Phone. The MOU is envisaged with PTT on the project of smart farming and production of fertilizer from waste.

3.3 Key Informants

The key informants in this research consisted of entrepreneurs who were successful Smart Farmers in their fields, including work process in farm and marketing with profitable sales, leading to self-reliance, and enhancement to other businesses.

In-depth interviews were conducted with entrepreneurs who were Smart Farmers in prototype farms in ten areas. The in-depth interviews were conducted on the management of Smart Farmers directly with ten entrepreneurs as in Table 3.3, interviews with nine experts involved in Smart Farmer agricultural practice as shown in Table 3.3

Table 3.3 Entrepreneurs

Rank	Names	Details
1	Director of Rice Production Promotion Office	Department of Rice, Ministry of Agriculture and Cooperatives
2	Deputy Director General	The Queen Sirikit Department Of Sericulture, Ministry Of Agriculture And Cooperatives
3	Agricultural Engineer, Senior Professional Level	Department of Agriculture Department of Agricultural Extension, Ministry of Agriculture and Cooperatives
4	Cooperative's Rice Business Specialist	Cooperative Promotion Department, Ministry of Agriculture and Cooperatives
5	Director of Aquaculture Research and Development Division,	Department of Fisheries, Ministry of Agriculture and Cooperatives
6	Specialist in Land Use Optimization in the Land Reform Area.	Agricultural Land Reform Office, Ministry of Agriculture and Cooperatives
7	Manager, team leader of the waste	PTT Public Company Limited

Rank	Names	Details
	management working group for the project "Khung Bang Ka Chao Rao"	
8	Sampran Model Project	Managing Director of Suan Sampran
9	Kubota Farm Manager	Kubota Farm Chonburi Province

Table 3.4 Experts Related to Smart Farmer Agricultural Practice.

Ranks	Names	Responsibilities
1	Ministry of Agriculture and Cooperatives	1) Formulates policy of the country's agricultural promotion 2) Serves as sources of knowledge, information, and news on agriculture 3) Promotes and develops farmer institutions 4) Supports production factors to farmers and 5) Cooperates and coordinates with other agencies
2	Office of the National Economic and Social Development Council	1) Develops farmers' secure quality of life 2) Develops agricultural economics for secure growth 3) Promotes the promotion of quality agricultural goods in the supply chain that is in line with market demand and promotes research, technology, and innovation for utilization 4) Promotes balanced and sustainable management of agricultural resources and environment
3.	Ministry of Natural Resources and Environment	1) Converses policy at the national and ministerial levels towards the plan of management of natural resources and environment at all levels 2) Drives, operates, supports, controls, supervises, follows up, investigates, monitors, prevents, and evaluates balanced and sustainable

Ranks	Names	Responsibilities
		natural resources and environment
4	Ministry of Interior	Responsible for occupational promotion and people's well-being which requires close coordination and cooperation with other government agencies, relevant ministries, bureaus, departments. Also responsible for setting up farmer groups, protection of farm tenants, development of water sources of small farming outside irrigation areas, and irrigation built by people, etc.
5	Ministry of Commerce	1) Supervises prices of agricultural goods and farmers' income 2) Cares of consumers under the laws of Ministry of Commerce 3) Promotes and develops business and trade for both goods and services 4) Protects intellectual property

3.4 Methods of Data Collection

1) Secondary Data consisted of study of documents, research reports, and domestic and international articles related to Smart Farming in urban community. Concept and theory of Smart Farmer, Concept and theory of Knowledge Management, Concept and theory of Farmers' learning, Concept and theory of relevant policies and strategies, Concept and theory of Circular Economy, Concept and theory of the Urban Community, Concept and theory of CIPPI Model, Smart Farmer abroad and Relevant research works.

Interview Experts and Relevant agencies government and private sector.

Survey of 10 farm areas as case studies selected according to Smart Farming criteria.

2) Primary Data survey was conducted on 10 farm areas selected as case studies based on Smart Farming criteria. The survey covered general operations and environmental conditions of the Smart Farming in urban community, as well as

exploring the history of Smart Farming. In urban community, factors influencing Smart Farming in cities and knowledge about Smart Farming of entrepreneurs in urban community. along with interviews with experts and related agencies, both public and private sectors.”

3.5 Tools Used in the Research

The tools used in the research entrepreneur interview form ten case studies, expert and relevant agencies interview form and model assessment form were divided into three parts as follows:

1) In-depth interview form for entrepreneurs on Smart Farmer agricultural practice in urban community with the following questions:

(1) How much do personnel have knowledge, and understanding of Smart Farming agricultural practice?

(2) Are personnel proud to be farmers?

(3) Is the budget for Smart Farming agricultural practice in urban community sufficient?

(4) Is there budget support from relevant agencies? What is the budget?

(5) Are equipment and tools for Smart Farming agricultural practice in urban community sufficient?

(6) Do farmers have sufficient up-to-date information or have access to information for decision-making?

(7) Do entrepreneurs have perception of Smart Farming from learning and practice to be used in their own farm? How?

(8) Do entrepreneurs have knowledge and understanding on Smart Farming agricultural practice in urban community and can they transfer the knowledge to interested persons?

(9) Do entrepreneurs have knowledge or attend training on the GAP/GMP standards of organic farming, safety standards of goods, or other standards? What are they?

2) In-depth interview form with Smart Farming on successful management process using Information Technology with the following questions:

(1) Is there process of Smart Farming agricultural practice in urban community?

(2) Do entrepreneurs plan production in response to demand and do they manage output and marketing? How?

(3) Is there process of Smart Farming in urban community? How? Is it appropriate to the environment of urban community? How?

(4) Are there follow-up and assessment of Smart Farming in urban community? How?

(5) Is the value of the agricultural practice in accordance with lifestyle? What are the characteristics of individual operation?

(6) Do entrepreneurs use, develop, or improve technology, local wisdom, and best practice?

3) In-depth interview form of entrepreneurs on problems, obstacles, success, comments and additional recommendations, as well as the key success factors of Smart Farmer agricultural practice with the following questions:

(1) What is the income of Smart Farming practice in urban community?

(2) What is the output from Smart Farming practice in urban community?

(3) Are entrepreneurs responsible for the environment/the society? Do they have production process that does not generate pollution and is environmental-friendly (Green economy)? Do they organize continuous CSR activities? How?

(4) Is there environmental management for Smart Farming in urban community without destruction of the human, economic, social, resource, and environmental cycle? How?

(5) Does Smart Farming in urban community impact the ecosystem, air, water, noise, and waste? How?

(6) Can the entrepreneurs efficiently conduct the Zero waste management? How?

(7) Does Smart Farming in urban community have good management of quality of life? How?

(8) Does Smart Farming in urban community bring out the Circular Economy in the community? How?

4) Interview form for experts related to Smart Farmer agricultural practice and relevant agencies such as Ministry of Agriculture and Cooperatives, Ministry of Commerce, etc. The questions were as follows:

(1) How much do the personnel in the agencies have knowledge and understanding on Smart Farming?

(2) How are the personnel in the agency proud to cooperate with the Smart Farming policy?

(3) How does your agency's policy and working guideline respond to the needs of Smart Farming?

(4) Does your agency have strategy on Smart Farming?

(5) Does your agency have analysis and planning personnel to enable Smart Farming to grow and prosper? If yes, what are the operational processes?

3.6 Research Methods

The research project followed the following processes:

1) Literature review and design of education by reviewing relevant concepts, theories, and research works in line with the objectives of the research, and study of Smart Farmer agricultural practice in urban community.

2) Coordination with Smart Farmers for request to conduct research.

3) Compilation of information from in-depth interviews with entrepreneurs on the practice of Smart Farmer in urban community, process of management of the successful use of IT, problems, obstacles, success, comments, and additional recommendations, as well as the key success factors of Smart Farmer agricultural practice, interview form with experts on Smart Farmer agricultural practice and relevant agencies.

4) Compilation and analysis of information from in-depth interviews to analyze the key success factors of Smart Farmer agricultural practice in urban community and recommendations of the model of sustainable Smart Farmer in urban community, consisting of Input, Process, Output, and Outcome, and Impact.

5) Test Model: Based on the presentation of the model of sustainable Smart Farming for farmers in urban community through the online meeting with the Smart Farming entrepreneurs of the 10 case studies using the conceptual framework of the model of Smart Farming.

6) Summary of results and writing of research report.

3.7 Inspection of The Quality of Data-Collecting Tool

In terms of the qualitative data-collecting tool, the researcher asked the experts on smart farming to jointly consider the questions. The data from the interviews with entrepreneurs who collected data by using the data from the collection of secondary data, documents, and research works relevant to agriculture and compared it with the interview data and study of the smart farming.

In terms of the Content Validity of the data-collecting tool, 10 experts inspected the Content Validity of the questions consisting of content, measurement and assessment, use of language by comparing with the research objectives. The question which was congruent would receive 1 mark, not certain 0 mark, and non-congruent -1 mark, as for the value of IOC (Index of Item – Objective Congruence), choose the question with the value of IOC higher than 0.5 – 1.00 and improve the questions with the value of IOC lower than 0.5 according to the opinions and recommendations of the experts for more completeness. The content validity of this research was 0.82.

3.8 Data Analysis

The data analysis in this study was the analysis of qualitative data from the analysis of CIPPI model used with the interview results of entrepreneurs of Smart Farming, experts, and relevant agencies to study the Smart farming situation in urban

community, the problems, obstacles, and success, as well as success factors of practicing Smart farming in urban community and the sustainable model of Smart farming in urban community and then were used for descriptive summary. The obtained information was used to present the sustainable model of Smart farming in urban community.

The analysis of qualitative data from in-depth interviews with the entrepreneurs, interviews with experts relevant to smart farming practice, and relevant agencies included Ministry of Agriculture and Cooperatives, and Ministry of Commerce, etc. The interview results were used for Content Analysis using the CIPPI Model namely 1) Context Evaluation 2) Input Evaluation 3) Process Evaluation 4) Product Evaluation 5) Impact assessment Descriptive summary use condition to compare data from various methods to collect information It also uses the perspective of various theories. To consider the same set of data and explain the findings through interpretation and analysis that can be used in other studies. 6) Test Model: Based on the presentation of the model of sustainable Smart Farming for farmers in urban community through the online meeting with the Smart Farming entrepreneurs of the 10 case studies using the conceptual framework of the prototype Smart Farming (Stufflebeam, 1971 as cited in Chamlong Poboon, 2017).

CHAPTER 4

RESEARCH RESULTS

4.1 Analysis of Relevant Situations, Measures, Policies, Strategies, and Plans

4.1.1 Analysis of the Smart Farming Situations in Thailand

In order to reach the targets as specified in the 12th National Economic and Social Development Plan, the development of Smart Farming ranked high in the priority in the Development Plan (2017-2022). Based on the overall data analysis of the drive of Thailand's smart farming, as well as the past performance, the current drive of the smart farming focuses on the following:

- 1) Definition of "Smart Farming" must be clear. Each agency provides different definitions. For example, an agency defines smart farming specifically for the use of technology for cultivation or defines the farmer with knowledge and ability to create agricultural innovation. In fact, "Smart Farming" means the agricultural methods with area analysis, focus on increased efficiency, by increasing productivity per area, increasing output's value-added, principle of working less for more output, use of technology and smart agricultural machinery, control of production process starting from cultivation, care, harvest, transport, and processing, as well as data storage for future benefit such as the use of Agri-Map to inspect the soil conditions and select seeds, control the amount of light, humidity, and temperature, determination of appropriate amount of nutrients and water, use of sensor system to manage plots and greenhouses, pest control, long-distance order by using Artificial Intelligence (AI) to support, as well as planning and decision-making of agricultural practice based on the correct IT database through the development of Big Data Platform on smart farming to ensure production precision. The development of smart farming to reach the target requires the drive of major components in 5

parallel dimensions namely farmer, technology, production process and harvest, market, and capital.

2) The drive of smart farming still lacks integration of relevant agencies. Smart farming is driven by many agencies. But each relevant agency acts on its own without integration or cooperation. Ministry of Agriculture and Cooperatives focuses solely on development of knowledge for farmers to know the concept of Smart Farmer and not on the development of other fields. Moreover, the Ministry's projects are repetitive and similar. At the same time, Ministry of Higher Education, Science, Research, and Innovation and the local academic institutions focus on the development of technology and research but do not have capital for farmers to buy technology. Ministry of Commerce does not clearly provide marketing support for higher output from Smart Farming. Bank for Agriculture and Agricultural Cooperatives offers loan projects for farmers but not specifically for Smart Farming. Some agencies separate promotional measures based on output. For example, National Science and Technology Development Agency (NSTDA) operates the project to support the development of agricultural technology in the east by focusing on the drive of smart farming to increase efficiency in fruit cultivation and processing. National Innovation Agency provides funds to support the private sector in the northeast to use technology for cassava cultivation, etc.

3) There is no host agency to supervise the holistic and integrated policy of Smart Farming. For example, if a farmer wants to join Smart Farming by developing his or her own knowledge through technology but lacks capital, the farmer must contact Ministry of Agriculture, Ministry of Higher Education, Science, Research, and Innovation, and Bank for Agriculture and Agricultural Cooperatives by himself or herself. Therefore, the host agency should be clearly determined. For example, Ministry of Agriculture and Cooperatives may serve as the core agency for the integration between agencies, as well as coordination and forwarding work from one agency to another in an integrated manner.

Smart farming is one of the important policies to upgrade Thailand's agriculture. It requires integration between knowledge, information, and various methods from many sectors. Another important issue is to gradually upgrade technology to higher level. It means that after promoting farmers to use

unsophisticated technology such as drone, water drifting system, and solar cell energy, the use of more advanced technology should be driven such as agricultural robot, or Artificial Intelligence (AI).

Based on the information of Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, between 2018-2022, it was found that the target farmers met the qualification assessment (Smart Farmer). In 2018, the number increased 140.61% but decreased to 93.61% in 2019. In 2020, the number exceeded the target 104.25%. In 2021, the number was 100% on target. In 2022, the number decreased to 98.99%. In terms of the development of Smart Farmer to become Smart Farmer Model, in 2018, it met with success and was on target with 100.00% but decreased to 34.93% in 2019. Then in 2020, the number exceeded the target 101.98%. In 2021, the number was 100% on target and in 2022, it exceeded the target 100.323%.

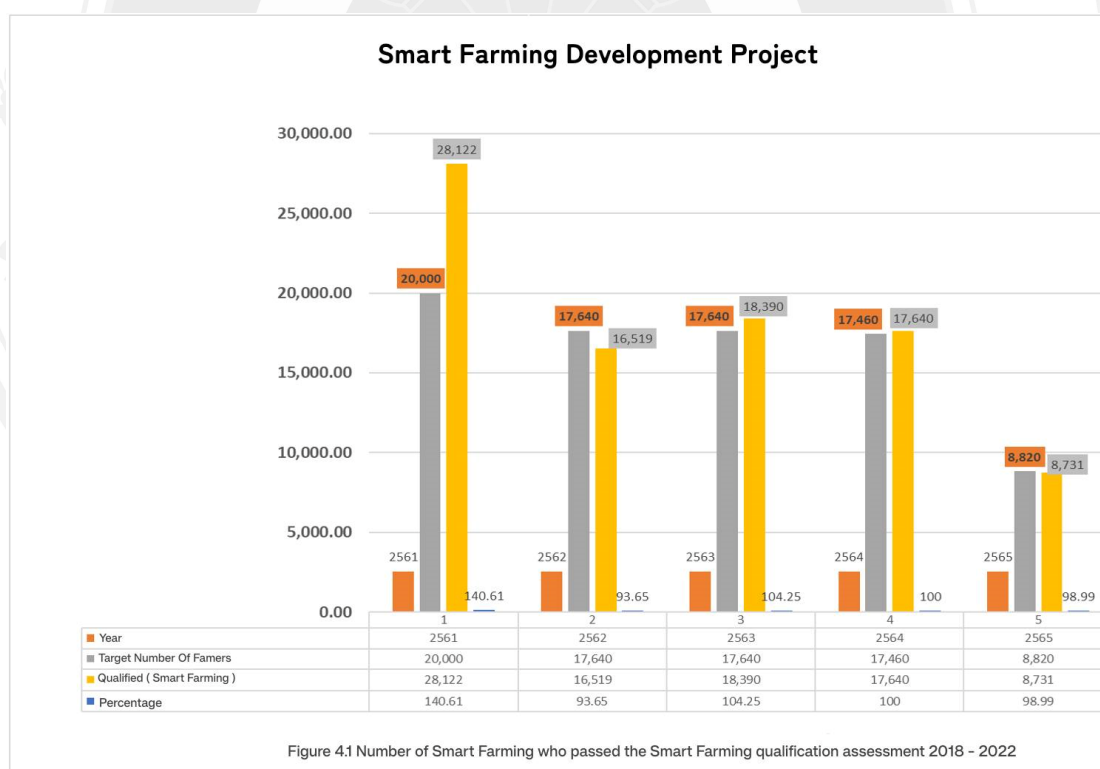


Figure 4.1 Number of Smart Farmer Who Passed the Smart Farmer Qualification Assessment 2018-2022

Note: Information of Department of Agricultural Extension, Ministry of Agriculture

and Cooperatives 2022

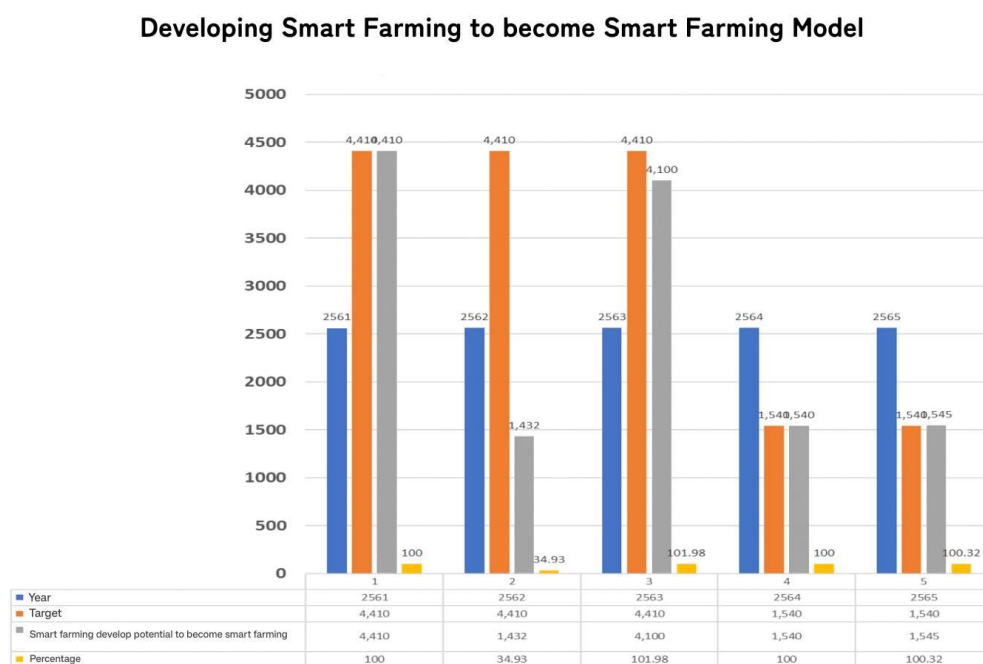


Figure 4.2 Number of Smart Farming through the Smart Farming qualification assessment 2018 - 2022

Figure 4.2 Number of Smart Farmer through the Smart Farmer Qualification Assessment 2018-2022

Note: Information of Department of Agricultural Extension, Ministry of Agriculture and Cooperatives 2022

4.1.2 Government's Measures and Policies to Promote Smart Farming in Thailand

The study of the connection to drive the development of Smart Farming in the National Strategy, Master Plan under the National Strategy, National Reform Plan, and 13th National Economic and Social Development Plan is the task that is jointly performed under the action plan on the promotion of integrated grassroots economy consisting of 8 agencies at the ministerial level as follows:

4.1.2.1 Ministry of Agriculture and Cooperatives

The Ministry formulated the Smart Agriculture Action Plan 2022-2023 with the guideline to develop the Smart Agriculture Action Plan in 6 dimensions as follows: 1) Research and development on smart farming technology 2) Build

learning plots of smart farming 3) Awareness, access, utilization, and promotion of enhancement on smart farming technology 4) Develop processing and marketing of smart farming 5) Promote and develop digital technology for smart farming management and 6) Develop personnel and smart farming network by assigning Department of Agricultural Extension as a major operating agency. The definition of “Smart Farming” is given herewith “Farmer who is knowledgeable in what he/she is undertaking, equipped with information to accompany decision-making, with awareness of product quality and consumer safety, CSR, and pride of being farmers”.

4.1.2.2 Ministry of Higher Education, Science, Research, and Innovation

The Ministry’s role is to promote OTOP communities and entrepreneurs to use “Science, Technology, and Innovation” in developing community products. Such role can develop smart farmers by applying science, technology, and innovation o develop production of agricultural products, output processing, and product/processed product development under the project to integrate and promote the grassroots economy. The agencies operating the projects are as follows:

- 1) Office of the Permanent Secretary of the Ministry of Higher Education, Science, Research, and Innovation has operated the project to develop community products continuously since 2017. The development of community products and upgrading of 5 types of OTOP products include food, beverage, herb (non-food), fabric, and garment, as well as appliance, decoration, and souvenir. Moreover, there are 6 guidelines for the development of community products namely development of raw material quality, development of production process, standard upgrading, packaging development and design, machinery development and design, and product innovation development. The budget can be sought under the name “OTOP Coupon.”

- 2) Department of Science Service with the action plan to integrate the development and promotion of grassroots economy relevant to its work. The objectives include the following: increase income for communities and farmers and reduce income inequality of population, develop the potential of low-income people to gain access to input resources, professional development promotion,

development of the strength of groups and community products, as well as development of management system and marketing mechanism.

3) National Science and Technology Development Agency (NSTDA) with its agency responsible for promotion and development of smart farmer that is Agricultural Technology and Innovation Management Institute. It provides services of integrated agricultural technology and innovation, services of knowledge and information of agricultural technology and innovation, diagnosis of problems, consultancy, search for appropriate technology, appropriate trainings and technology transfer, promotion of learning, creation and connection of network, cooperation between farmers/communities, public and private sectors through cooperation with partner agencies both public and private.

4) Mae Fah Luang University by Integrated Herbal Innovation Center operates under the action plan of integrated development and promotion of grassroots economy under the activity “integrated and comprehensive production of herbal raw materials to increase income for the economy of the community in Chiang Rai”.

5) Kasetsart University Kamphaeng Saen Campus occupies the area of approximately 8,000 rai with many facilities for learning and practices. At present, it creates the platform “Agri Innovation Park” responsible for instruction, research, academic services, community services in various dimensions such as output production and processing, technology transfer, business-based marketing, center for plant and animal research, clinic for plant pests, animal pests, insects, agricultural machinery, digital technology, Seed Bank, breeding system, national center for promotion and training of agricultural vocation, project to recruit B.A. students (1 province 1 student), project of 4H of young farmers for knowledge transfer, online market, and weekend market of farmer groups to assist the promoted groups.

6) Kamphaeng Phet Rajabhat University operates under the university’s strategic plan to connect with the provincial strategy for local development. Most are relevant to agriculture with focus on safe farming, smart farmer, and increased value of agricultural output across the supply chain.

7) Sisaket Rajabhat University receives the budget to operate the projects relevant to development and promotion of grassroots economy such as the Project “Processing of products from naturally dyed nano reed to develop and promote the grassroots economy in Si Sa Ket” in order to develop the pattern of the product from naturally dyed nano reed for higher value.

8) Nakhon Phanom University in the budget year 2020 received the budget from Ministry of Agriculture and Cooperatives under the “Project to develop the innovation of low-cost animal feed production to increase competitiveness of beef cattle breeders”. The project developed the tools to produce and process output with new innovation that is the semi-automatic corn/grass Silage, high-speed animal feed pellet machine, TMR, cereal, and agricultural residues, and innovative Folder System to produce high-speed production of sapling. The University has undertaken technology transfer to 1,000 farmers.

4.1.2.3 Ministry of Interior

Ministry of Interior is an important agency that supports the drive of smart farmers since its inception. The assigned vice/deputy governor is appointed as the chairman of the working group to drive smart farmer at the provincial level. Moreover, Community Development Department, under the Ministry of Interior, is responsible for promotion and development of profession, promotion of processing and products, promotion of market, as well as support of capital through funds. Smart farmer is one of the target groups for development of Community Development Department. The Department develops the potential of target people, development of the strength of groups and community products, including development of management system, and market mechanism.

4.1.2.4 Ministry of Industry

Ministry of Industry has agencies responsible for the study of the agro-industrial situations to formulate the appropriate action plan and the project for agro-industrial development to ensure the efficient competitive agro-industrial entrepreneurs. Moreover, the Ministry also promotes and develops agro-industrial business management to increase productivity in various operations which increase competitiveness for agro-industrial entrepreneurs to develop and increase value of agro-industrial products, as well as develop new agro-industrial products that expand

market opportunities. Innovative Agriculture-Industry Development Division is an internal agency under Department of Industrial Promotion, established on February 27, 2020 aims to facilitate the promotion and development of agro-industry according to the government's policy to make connection from upstream farmers to midstream producers and to downstream market operations which will upgrade income and strengthen the grassroots economy as a whole to ensure flexibility in performing duties to support agro-industrial entrepreneurs to achieve efficient competitiveness.

4.1.2.5 Ministry of Natural Resources and Environment

Biodiversity-based Economy Development Office (Public Organization) or BEDO is responsible for promotion and development of bio-based economy by focusing on natural capital which means the utilization of resources of biodiversity and community and local wisdom in terms of sustainable economy in parallel with balanced preservation to provide the opportunity to generate employment, income, and stimulate new entrepreneurs. The role and duty can develop smart farmers into new entrepreneurs.

4.1.2.6 Ministry of Digital Economy and Society

The mission of Digital Economy Promotion Agency (DEPA) promotes and supports the application of digital technology and innovation in business and industry. It therefore realizes the importance of promotion of farmers' digital application, as well as credibility to Thailand's business and agricultural products to drive and upgrade agricultural product standards towards international practices, resulting in the rapid and efficient development of farmers towards the Smart Farmer as well as increase higher value output.

4.1.2.7 Ministry of Commerce

Ministry of Commerce's 2 agencies namely Department of Internal Trade and Department of Business Development are responsible for the development of management system and market mechanism both online and offline to develop smart farmers in terms of market and entrepreneurship under the 2022 action plan to integrate the grassroots economy with the following operation:

- 1) Department of Internal Trade is responsible for the development of smart farmer according to the guideline to develop management system and marketing mechanism.

2) Department of Business Development is responsible for the development of smart farmer under the National Reform Plan on economy, the plan to integrate the development and promotion of grassroots economy, the guideline to develop the management system and marketing mechanism, the project to promote mechanism development, the structure to absorb economic value, and distribution of income to local areas.

4.1.2.8 Ministry of Finance

Ministry of Finance supervises financial institutions. The financial institution that directly relates to agriculture is the Bank for Agriculture and Agricultural Cooperatives. It is responsible for financial assistance to farmers, farmer groups and agricultural cooperatives for the practice of agriculture and other agriculture-related professions to increase income or develop quality of life of farmers and family members. The financial institution is a major capital for the development of smart farmers.

1) Bank for Agriculture and Agricultural Cooperatives defines the guideline to create economic activities related to the grassroots economy and upgrade the quality of life of rural people as follows:

(1) Create and develop farmers to become smart farmers and small and medium agricultural enterprises (SMAEs) with focus on competitiveness by using production and processing technology and innovation

(2) Increase competitiveness for small farmers with the mechanism of Smart Farmer, SMAEs, and farmer institutions

(3) Develop the potential of organization and community in an integrated and sustainable manner to develop the grassroots economy, and focus on the development of the potential of organization and community in an integrated and sustainable manner with network to upgrade community economy (Report on the study to drive the Smart Farmer based on the National Reform Plan and 20-Year National Strategy, Senate Committee on Agriculture and Cooperatives, Secretariat of the Senate) From the National Strategy, Master Plan under the National Strategy, National Reform Plan, and 13th National Economic and Social Development Plan, they connect the strategy to allocate budget, determine the development of smart farmer and in other areas relevant to the

strategies and action plans in each level leading to the implementation under the budget “Action Plan to integrate and promote the grassroots economy”. It is the last goal which is “Target people earn more”. But some farmers still lack knowledge and confidence that the Smart Farming system will really reduce agricultural costs. At the same time, some of the Smart Farming costs are still high and with long payback period. As a consequence, farmers hesitate to apply the system. It is difficult and complicated for most farmers to use technology and innovation on a wide scale due to the following problems:

(3.1) It is difficult for the investment in technology and innovation to succeed for farmers as it is necessary to invest in the process to create the environment that is consistent with the technology and innovation as well. For example, if a farmer wants automatic water system through the control of water in the farm via smartphone, the farmer has to pay the engineer to design the power system from the old home power system to the plant power system in order to sufficiently respond to the amount of power consumption. Until the system can really function, there will be additional expenses such as irrigation system, land planning, foundation of water pipe system, etc. They all require various knowledge in the design and creation of system for real functioning.

(3.2) The advanced technology is too complicated for the farmers who lack knowledge and understanding to use it. The design of Smart Farming must be specific for the farmers for uncomplicated practicality. Although technology and innovation are of good quality, with the advanced technology providing information to the farmers in detail, and the system with complete data, it is too difficult for general farmers to practice. This may contribute to the reason that Smart Farming is not successful. Technology and innovation are the work of various producers by which each company develops and competes in terms of quality and prices. But some information is the trade secret and cannot be disclosed. When farmers use it practically, the products from different sources are not compatible and cannot be efficiently connected because the producer in each company has different standard of the product. So, with defects in connection and difficulty in functioning, the problem greatly impacts the farmers.

(3.3) Unclear investment return. In general, small farmers have burden in their living. When investing in Smart Farming technology and innovation, they all have concern of the cost effectiveness and many hidden costs that will follow in the future. It is the main reason that small farmers cannot get access to technology and innovation.

The promotion of Smart Farming in Thailand concretely started in 2015. The administration of General Prayuth Chan-ocha, Prime Minister, set up the National Committee for Sustainable Development to drive the mission according to the UN Sustainable Development Goals (SDGs) for concrete results by 2030 as signed by the Thai government with the UN. The 3 goals include Economic Growth, Social Inclusion, and Environment Protection.

The sustainable development goals or SDGs are related to the development to ensure that all have good quality of life and balanced co-existence with the environment. Farmer groups can participate in the development according to the guideline of SDGs through sustainable farming. It involves farming that covers the way of life of farmers, production process, and management of all forms to create economic, social, and environmental balance. For example, the change from monoculture to integrated farming, crop cultivation in big plots, reduced use of chemicals, use of technology and innovation towards Smart Farming which will reduce costs, and increase efficiency in farming will result in the overall self-reliance and development of farmers' quality of life.

Table 4.1 Policies, Plans, and Measures Relevant to the Promotion of Smart Farming

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
Plans at international level		
Sustainable Development Goals (SDGs)	United Nations	- Goal 9 Industry, innovation, basic infrastructure - Goal 12 Economic growth and sustainable development - Goal 15 Utilization of land eco-system; prevention, rehabilitation,

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
Plans at national level 20-Year National Strategy (2018-2037)	Public sector	and promotion of utilization of sustainable eco-system; formulation of the plan to drive the country's sustainable production and consumption; reduction of food loss and waste across supply chain, proper management of waste and chemicals to reduce pollution that is hazardous to human and environment; reduction of waste by supporting the practice of Reduce, Reuse, Recycle (3Rs); application of science, technology, and innovation to upgrade production and consumption; development of courses for sustainable development; promotion of clean energy to drive the country in the long term; development of industry, innovation, and basic infrastructure to have standard that facilitates Smart Farming to succeed National Strategy 2 Forge competitiveness with 3 concepts as follows: (1) “Enhance on the past” by looking back at the economic, cultural, traditional roots as well as identity, lifestyle, and strengths in natural resources (2) “Improve the present” towards the future through the country's basic infrastructure in many dimensions, including communication and transport system network, and scientific, technological, and digital basic infrastructure, and environmental

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
National Economic and Social Development Plans Draft 13 th National Economic and Social Development Plan 2023-2027	Public sector	improvement (3) “Create value for the future” by increasing potential of entrepreneurs, development of new generation of people, adjustment of business model in response to market demands National strategy on agriculture: Create value to foster competitiveness by focusing on increased output both in quantity and quality and diversity of agricultural goods consisting of the following: (1) Farming with local identity (2) Safe farming (3) Bio farming (4) Processed farming (5) Smart farming Milestone 1 Thailand is a leading country in high valued agricultural products and agricultural processing with the target to increase the value of agricultural products and processed agricultural products; develop basic infrastructure and agricultural management system for quality, food security, and agricultural sustainability; increase potential and role of agricultural entrepreneurs as economic partners in supply chain for appropriate and fair benefit-sharing. Increase GDP from agriculture to grow 4.5% a year; central regional markets for agricultural products with 2 in the north, 2 in the

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
		northeast, 2 in the south, 1 in the central regions, and 1 in the east; reduce the areas of floods, drought; community water system for 4,000 subdistricts; increase 4,000 agricultural entrepreneurs a year; examples of strategies; application of target-based technology and innovation; upgrading of production process and value-added creation; promotion of the private sector to invest in the development of central market and online market for agricultural products, including livestock and fishery Milestone 7 Thailand has strong, high potential, and competitive SMEs; the target that SMEs has environment facilitating growth and competition, with high potential in business operation, upgrading and adaptation towards new competition, ability to accede and effective promotion from the government; by 2027, increase GDP for SMEs 40% and increase domestic market share 25%; strategic examples include the following: development of eco-system to facilitate business operation and upgrade competitiveness of SMEs, promote SMEs to become entrepreneurs in the digital age, and develop the eco-system to facilitate startup business and entrepreneurs driven by innovation

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
Plans at ministerial level 5-Year Administration Plan 2023-2027	Ministry of Agriculture and Cooperatives	- Activities to develop the new generation of farmers - Activities to develop Smart Farmer - Develop Smart Farmer as model entrepreneur - Drive the development work of Smart Farmer -Land readjustment project operated since the beginning until the present in 27 provinces namely catchment area in 8 irrigation projects namely Chao Phraya Yai project, Phitsanulok project, Mae Klong Yai project, Nongwai Project, Nam Oon Project, Wang-Kewlom Project, Loei Irrigation Project, Anpuen Reservoir Project, and 1 catchment area project of Pumping Station Project that is Nakhon Si Thammarat Pumping Station Project including the total land readjustment of approximately 1.7 million rai “Project to develop the innovation of low-cost production of animal feed to increase potential and competition of beef cattle breeders”
2022 Action Plan of Ministry of Higher Education, Science, Research, and Innovation	Nakhon Phanom University	Target groups: 900 cow breeders (large plots and premium cow breeders) in Sakon Nakhon, Nakhon Phanom, Mukdahan Performances: - Establish the learning center of low-cost animal feed by developing the tools for production and processing of output with new innovation. The 2 completed innovation projects include semi-

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
2022 Administration Plan of Ministry of Commerce	Ministry of Commerce	automatic corn/grass silage, and high-speed animal feed pellet machine, TMR, cereal and agricultural residues, innovation of fodder system to produce high-protein grain sapling which is currently operating. Technology has already been transferred to 1,000 farmers. Organize activities to stimulate and link transactions of goods and services in Must-See market for 98 times and in the process of organizing festival of tourism and sales of goods and services of Must-See market - 7,192 shops participating in the project covering 77 provinces - Create the platform line chatbot including QR Code to provide information services, grocery stores in the neighborhood, grocery stores with delivery, activities to upgrade management standard of 22 participating entrepreneurs, in the process of counselling, assessment, and potential analysis - Encourage knowledge on e-commerce to 1,346 groups of farmers and community entrepreneurs in Phatthalung and Sukhothai - Competition activities for student under the project to develop online community goods by DBD with 1,817 participating students and 503

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
		participating teams - Promote online commerce to assist entrepreneurs of community goods and agricultural products impacted by COVID-19 with 50 participating target groups and over 60 products - Activity of Hook to local with 146 participating groups in 62 provinces - Promote market channels both online and offline by organizing 1 exhibition for 3 days
Plans at departmental level 2022 Administration Plan	Department of Agricultural Extension	- Activities to develop the new generation of farmers - Activities to develop Smart Farmers - Develop Smart Farmers as model entrepreneurs - Drive the department work of Smart Farmers
3-Year Administration Plan of Department of Fisheries (2020-2022)	Department of Fisheries	1. Develop and promote research and innovation on agriculture to increase value, leading to commercialization of innovative production - Develop agriculture with value creation by promoting research, development, and application of innovation in the country's target agricultural areas such as agricultural identity, safe farming, bio farming, processed farming, and smart farming to increase efficiency in production both quantity, quality, and output diversity, including upgrade income, reduce expenses, and reduce risk factors in farming for farmers, as well as maintain

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
3-Year Administration Plan of Rice Department (2020-2022)	Rice Department	biodiversity and local wisdom. The major research topics include develop animal breeds, reduce labor costs and input costs, weather forecast, analyze risk factors for agriculture, and maintain and process fishery products, etc.
		2. Develop and promote the use of technology and innovation to support precision agriculture - Develop the farmers' potential to accede and utilize technology and innovation on fishery, environmental-friendly agricultural management, knowledge on production and market, as well as utilization of space technology and geo-informatics, digital technology, agricultural database to plan production and develop farmers to become smart farmers Consists of 4 strategies in line with Ministry of Agriculture and Cooperatives with 4 performance highlights as follows: 1. Strengthen farmers and farmer institutions with focus on agricultural promotion 2. Increase efficiency in agricultural product management, develop and promote rice cultivation such as farming in large plots, develop the potential of agricultural production process, develop and promote production of agricultural goods 3. Promote the use of technology and innovation to increase agricultural competitiveness with focus on the use of technology and

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
3-Year Administration Plan of The Queen Sirikit Department of Sericulture (2020-2022)	The Queen Sirikit Department of Sericulture”	innovation in rice production 3.2.3 Administration Plan topic 3: Upgrade R&D on technology and innovation of sericulture 1) Goals 1.1) Silk farmers are competitive at international level 1.2) Research of the agency is developed, enhanced, and utilized in the fields of production and market
2022 Administration Plan of Cooperative Promotion Department	Cooperative Promotion Department	Administration Plan on the development and creation of potential of farmer institutions to increase efficiency in production and market across the supply chain Goals: 1.) Promote the use of technology and stimulate innovation for production and market across the supply chain in new processes 2) Cooperatives/farmer groups can apply technology to operation, provide services to members, and create innovation 3) Create 507 networks across the supply chain of business operation 4.) 146 cooperatives/farmer groups are promoted and developed for market management, connection, network/cluster 5.) 124 cooperatives/farmer groups, 2,568 cooperative members/farmer groups were promoted for production of safe agricultural products
5-Year Administration Plan (First phase 3 years 2020-2022)	Agricultural Land Reform Office	Goals at the issue level of the Master Plan: Goal 1: GDP for agriculture increases

Policies/plans	Agencies	Operations Relevant to The Promotion of Smart Farming
		Goal 2: Agricultural productivity increases on the average which meets the goal of the Master Plan. The data of Office of Agricultural Economics from the survey of the growth of GDP for agriculture in 2017 was the base year of 5.3% and set the goal for growth between 2020-2022 of 3.8% for food and create food security and safety at the household level

4.1.3 Analysis of Government Measures and Policies to Promote Smart Farming in Urban Communities

From the review of government measures and policies that promote smart farming (Smart Farming) in urban communities according to Section 4.1.2, were analyzed (1) characteristics of public policy (Public Policy), consisting of objectives, responsible agencies, and budget to support policy implementation appropriately (Thosaporn Sirisumphand, 2000) and (2) analyze three public policymakers who will influence or drive such policy formulation (Thosaporn Sirisumphand, 2000). It can be summarized as shown in the table. 4.2

The results of the analysis of policy characteristics to promote smart farming (Smart Farming) in urban communities found that most of the policies were formally set by public policy makers. The policy has been pushed to the fullest, together with having a model that is a conceptual framework for setting that policy. As a result, clear objectives are set. Responsible agencies are clearly defined. But the transfer from policy to action plan and support budget approval is unclear. This disadvantage may result in the policy not being able to achieve the objectives and goals set by each agency.

Table 4.2 Analysis of Government Measures and Policies to Promote Smart Farming in Urban Communities

Policy/Plan	Policy Maker	Objectives	Responsible Agencies
International Plan	Official Key Policymakers	-Goal 9 Industry Innovation Infrastructure	Countries participating in the agreement
Conference of Parties to the 26th Session of the United Nations Framework Convention on Climate Change (COP26) Sustainable Development Goals' SDGs		- Goal 12: To achieve economic growth and sustainable development. Goal 15: Use of Terrestrial Ecosystems, Protect, Restore and Promote Sustainable Use of Ecosystems	
Conference of Parties to the 27th Session of the United Nations Framework Convention on Climate Change (COP27) Sustainable Development Goals' SDGs	Official key policy makers	- Goal 12: To achieve economic growth and sustainable development. - Setting a target to reduce greenhouse gas emissions by 40% by 2030 and setting a carbon neutral target by 2050 and the urgent need to keep global temperatures below 1.5 degrees.	Countries participating in the agreement.
National plan 20-Year National Strategic Plan (2018-2037)	Official key policy makers	National strategy, aspect 2: building competitiveness. It has three concepts: (1) "Building on the past"(2) "Current Adjustment" (3) "Creating new values in the future"	Public sector

Policy/Plan	Policy Maker	Objectives	Responsible Agencies
National Economic and Social Development Plan Draft National Economic and Social Development Plan No. 13 B.E. 2566-2570	Official key policy makers	Pin No. 1 Thailand is a leading country in high-value agricultural and processed agricultural products. Pin 7: Thailand has small and medium-sized enterprises that are strong, have high potential, and are competitive.	Transfer to the responsible agency.
Ministry level plan Government action plan for 5 years (2023-2027) Ministry of Agriculture and Cooperatives	Official Deputy Policymaker -	-Project to promote and develop new generation of farmers to be Young Smart Farmer -Land readjustment project	Transfer to the responsible agency.
Ministry of Higher Education, Science, Research and Innovation Action Plan Fiscal Year 2022	Official Deputy Policymaker	Low-cost animal feed production innovation development project to increase potential Competition of Beef Farmers”	Ministry of Higher Education, Science, Research and Innovation
2022 annual government action plan of the Ministry of Commerce	Official Deputy Policymaker	- Community market project for local businesses Trader Potential Promotion Program and a project to develop community products into the online market	Department of Internal Trade and Department of Business Development

Policy/Plan	Policy Maker	Objectives	Responsible Agencies
Department level plan Government Action Plan 2022, Department of Agricultural Extension	Official Deputy Policymaker	1) Encourage and develop farmers to become Smart Farmers 2) Encourage new generations to enter the agricultural sector and develop them to become Young Smart Farmers 3) Encourage Farm Youth to have a positive attitude toward farming careers 4) Encourage elderly farmers And support those who retire from other occupations. 5) Organize, coordinate, integrate work with all sectors.	Department of Agricultural Extension
Action Plan of the Department of Fisheries for 3 years (2020 - 2022), Department of Fisheries	Official Deputy Policymaker	1. Develop and promote research and innovation in agriculture to add value and lead to Commercial Innovation Production 2. Develop and promote the use of technology and innovation to support Precision agriculture technology	Department of Fisheries
3-year government action plan of the Rice Department	Official Deputy Policymaker	1. Strengthen farmers and institutions 2. Increase the	Department of Rice

Policy/Plan	Policy Maker	Objectives	Responsible Agencies
(2020 - 2022)		efficiency of agricultural product management, focusing on the development and promotion of rice production. 3. Promote the use of technology and innovation to increase competitiveness in the agricultural sector. Focus on using technology and innovation in rice production.	
3-year government action plan (2020-2022) of The Queen Sirikit Department of Sericulture	Official Deputy Policymaker	1. S The Queen Sirikit Department of Sericulture producers have the ability to compete internationally. 2. The agency's research has been further developed and applied. Benefits in both production and marketing	The Queen Sirikit Department of Sericulture
2022 annual government action plan of the Department of Cooperative Promotion	Official Deputy Policymaker	1. Promote the use of technology and stimulate innovation in both production and marketing. 2. Cooperatives/Farmer groups can apply technology in their operations. 3. Create a	Cooperative Promotion Department

Policy/Plan	Policy Maker	Objectives	Responsible Agencies
		network throughout the supply chain to conduct business. 4. Cooperatives/Farmer groups are promoted and developed for marketing management and network connection. 5. Cooperatives/Farmer groups are promoted to produce safe agricultural products.	
5-year government action plan (first term 3 years 2020-2022), Office of Agricultural Land Reform	Official Deputy Policymaker	Goal 1. Gross Domestic Product in the field of agriculture increased. Goal 2. Agricultural productivity increased on average.	Agricultural Land Reform Office

From the review of government measures and policies that promote smart farming in urban communities according to Section 4.1.2, (1) the characteristics of public policy consist of objectives, responsible agencies, and budgets to support the implementation of the policy appropriately (Thosaporn Sirisumphand, 2000) and (2) analyze the three public policy makers who will influence or drive the formulation of such policies (Thosaporn Sirisumphand, 2000). This can be summarized as shown in Table 4.2.

Analysis of policy characteristics to promote Smart Farming in urban communities It was found that most of the policy was formulated by official public policy makers, so the policy was fully pushed, coupled with the presence of a model that provided a conceptual framework for that policy. As a result, clear objectives are defined. Responsible bodies are defined quite clearly. But the transition from policy to

action plan and approval of funding is unclear. This disadvantage may result in the policy not achieving the objectives and goals set by each agency. Table 4.2 Analysis of government measures and policies to promote smart farming in urban communities.

Table 4.3 Linkage of Policies and Plans Related to the Promotion of Smart Farming in Urban Communities.

Policy / Plan	Policy Makers	Objectives	Responsible Agencies
International Plan 26th Conference of States Parties to the United Nations Framework Convention on Climate Change (COP26) Sustainable Development Goals' SDG	Official Key Policy Makers	- Goal 9: Industry, innovation, infrastructure - Goal 12: Achieving Economic Growth and Sustainable Development - Goal 15 Utilization of terrestrial ecosystems, protecting, restoring and promoting sustainable utilization of ecosystems	Countries participating in the agreement
27th Conference of States Parties to the United Nations Framework Convention on Climate Change (COP27) Sustainable Development Goals' SDG	Official Key Policy Makers	- Goal 12 Achieving Economic Growth and Sustainable Development - Targeting 40% greenhouse gas reduction by 2030 and carbon neutrality by 2050, and an urgent need to control global temperatures to no more than 1.5%. degree	Countries participating in the agreement
National Plan 20-Year National Strategic Plan (2018-2037)	Official Key Policy Makers	National Strategy 2: Building Competitiveness There are 3 concepts: (1) “Building on the past”; (2) “adjust current”; (3) “Create new value in the future”	Public Sector

Policy / Plan	Policy Makers	Objectives	Responsible Agencies
National Economic and Social Development Plan Draft National Economic and Social Development Plan No. 13 2023-2027	Official Key Policy Makers	Pin 1: Thailand is a leading country in high-value agricultural and processed agricultural products. Pin 7 Thailand has strong small and medium enterprises with high potential and competitiveness.	Transfer to responsible authorities
Ministry-level plan 5-Year Government Action Plan (2023–2027) Ministry of Agriculture and Cooperatives	Official secondary policymakers	- Project to promote and develop young farmers to be Young Smart Farmers - Land Reform Project	Transfer to responsible authorities
Action Plan of the Ministry of Higher Education, Science, Research and Innovation for Fiscal Year 2022	Official secondary policymakers	Development of innovative low-cost feed production to increase potential Competition of beef cattle farmers.	Ministry of Higher Education, Science, Research and Innovation
Annual Action Plan B.E. 2565 of the Ministry of Commerce	Official secondary policymakers	- Community Market Project for Local Businesses Merchant Empowerment Project and Community Product Development Project to Market Online	Department of Internal Trade and Department of Business
Department Level Plan Government	Official secondary	1) Promote and develop farmers to be Smart	Department of Agricultural

Policy / Plan	Policy Makers	Objectives	Responsible Agencies
Action Plan 2022, Department of Agricultural Extension	policymakers	Farmers 2) Encourage the new generation to enter the agricultural sector and develop to be Young Smart Farmers 3) Encourage Farm Youth to have a positive attitude towards agricultural occupations 4) Promote elderly farmers and support those who retire from other occupations 5) Organize, coordinate and integrate with all sectors	Extension
Department of Fisheries 3-Year Action Plan (2020 – 2022) Department of Fisheries	Official secondary policymakers	1) Develop and promote agricultural research and innovation to add value and lead to commercial innovation production. 2) Develop and promote the use of technology and innovation to support Precision agriculture	Department of Fisheries
3-Year Government Action Plan of the Department of Rice (2020 - 2022)	Official secondary policymakers	1) Strengthen farmers and institutions 2) Increase the efficiency of agricultural product management, focusing on the development and promotion of rice production. 3) Promote the use of technology and innovation to increase competitiveness in the	Department of Rice

Policy / Plan	Policy Makers	Objectives	Responsible Agencies
		agricultural sector. Focus on using technology and innovation in rice production.	
3-year government action plan (2020 – 2022) of Mulberry Department	Official secondary policymakers	1) The Queen Sirikit Department of Sericulture manufacturers have the ability to compete at the international level. 2) The research of the agency has been further developed and applied. Benefits in both production and marketing	THE Queen Sirikit Department of Sericulture
2022 Annual Government Action Plan of the Department of Cooperative Promotion	Official secondary policymakers	1) Promote the use of technology and stimulate innovation in both production and marketing. 2) Cooperatives/farmer groups can apply technology to their operations. 3) Build a network throughout the supply chain. 4) Cooperatives/farmer groups are promoted and develop marketing management. Network Linking 5) Cooperatives/farmer groups have been promoted to produce safe agricultural products	Department of Cooperative Promotion

Policy / Plan	Policy Makers	Objectives	Responsible Agencies
5-Year Government Action Plan (First 3-Year Term 2020 – 2022)	Official secondary policymakers	Goal 1Gross domestic product in the field of agriculture increases. Goal 2 Increase agricultural productivity by achieving the average goal according to	Office of Agricultural Land Reform

Policies and plans for the promotion of smart farming in urban communities Align and transfer operations from top-level plans to plan-level plans to action-level plans with targets and responsible departments. As shown in Table 4.3, it is linked to international plans such as COP27 and the Sustainable Development Goals' SDG17, which aims to reduce greenhouse gases in order to reduce impacts related to climate change and encourage countries to pay attention to solving environmental problems that arise in order to cooperate for sustainability. This is in order to achieve the international plans that Thailand has agreed with and contribute to sustainable climate change in the future. It can be seen that the Level 1 Plan, the 20-Year Strategy (2018-2037), the National Strategy 2, building competitiveness with three concepts: (1) "Building on the past" by looking back to the roots of identity economy; (2) "Adjust the present" to pave the way for the future through the development of the country's infrastructure in various dimensions, including transportation and transportation networks, science, technology, and digital infrastructure, and environmental adjustment. (3) "Create new value in the future" by increasing the potential of entrepreneurs, developing the new generation, and adjusting business models to respond to market demands. The National Strategy on Agriculture creates value to be competitive, with emphasis on increasing production productivity both quantitatively and value-intensively, and the 13th National Economic and Social Development Plan 2023-2027 aims at industrial targets. Innovation, Infrastructure To achieve economic growth and sustainable development and the utilization of terrestrial ecosystems. protect Restore and promote sustainable ecological utilization Five-Year Government Action Plan (2023–2027) The Ministry of Agriculture and Cooperatives has promoted and developed young farmers to be Young Smart Farmers and has guidelines for

developing into agricultural entrepreneurs using modern technology. It focuses on changing the paradigm of agricultural entrepreneurship, adjusting the concept and creating motivation for agricultural careers. Focus on self-analysis to create a self-improvement plan. The development of agricultural activities with Innovation, Smart Farm, and Digital Market to expand from concept to practice, has prepared a preliminary agribusiness plan and developed into entrepreneurship. Full Agriculture is the development of Young Smart Farmer to be a new generation of agricultural entrepreneurs with agricultural management with modern technology, creativity, innovation, agribusiness planning with the concept of market-led production and stable income to achieve development to become a global agricultural entrepreneur.

Table 4.4 Linking Policies and Plans Related to The Promotion of Smart Farming in Urban Community

International Plan	(Sustainable Development Goals' SDG) COP27 - Target to reduce greenhouse gases by 40% by 2030 - Carbon Neutrality Target 2050 - The urgent need to control global temperature not to exceed 1.5% degree	(Sustainable Development Goals' SDG) COP26 - Goal 9: Industry, innovation, infrastructure -Goal 12: Achieving Economic Growth and Sustainable Development - Goal 15 Utilization of terrestrial ecosystems, protecting, restoring and promoting sustainable utilization of ecosystems
Level 1 Plan	20-Year National Strategic Plan (2018-2037) National Strategy 2: Building Competitiveness There are 3 concepts: (1) "Building on the past"; (2) "adjust current"; (3) "Create new value in the future"	13th National Economic and Social Development Plan 2023-2027 Pin 1: Thailand is a leading country in high-value agricultural and processed agricultural products. Pin 7 Thailand has strong small and medium enterprises with high potential and competitiveness.

International Plan	(Sustainable Development Goals' SDG) COP27 - Target to reduce greenhouse gases by 40% by 2030 - Carbon Neutrality Target 2050 - The urgent need to control global temperature not to exceed 1.5% degree	(Sustainable Development Goals' SDG) COP26 - Goal 9: Industry, innovation, infrastructure -Goal 12: Achieving Economic Growth and Sustainable Development - Goal 15 Utilization of terrestrial ecosystems, protecting, restoring and promoting sustainable utilization of ecosystems
Level 2 Plan	Government Action Plan of Ministry of Agriculture and Cooperatives 5-year term (2023–2027) -Develop farmers' potential to access and utilize technology and innovation. Agriculture -Environmentally friendly agricultural sector management, including production and marketing know-how, as well as utilization of space and geo-information technology. Digital Technology Various agricultural information databases for agricultural planning and development of farmers to be smart farmers with competitive capabilities.	Action Plan of the Ministry of Higher Education, Science, Research and Innovation for Fiscal Year 2020-2027 - Agricultural innovation for sustainable development with knowledge and ability in value chain management - Able to create value to connect production and marketing to sell produce and profitably. - Cost-effective production costs and reduce production costs by 15%
Level 3 Plan	Department of Fisheries 5-year action plan (2023 – 2027) 1) Promote the development of plant varieties. Animal breeds Inputs Agricultural machinery and equipment, as well as future agricultural technologies and innovations. 2) Develop farmers' potential to access and utilize technology and innovation. Agriculture 3) Support and promote smart farming systems	5-Year Government Action Plan, Department of Agricultural Extension (2023 – 2027) 1) Promote and develop farmers in modern farming and the use of smart technology. 2) Promote the use of good varieties Quality inputs Agricultural machinery and equipment, transfer knowledge in production, marketing Eco-friendly production management Able to cope with

International Plan	(Sustainable Development Goals' SDG) COP27 - Target to reduce greenhouse gases by 40% by 2030 - Carbon Neutrality Target 2050 - The urgent need to control global temperature not to exceed 1.5% degree	(Sustainable Development Goals' SDG) COP26 - Goal 9: Industry, innovation, infrastructure -Goal 12: Achieving Economic Growth and Sustainable Development - Goal 15 Utilization of terrestrial ecosystems, protecting, restoring and promoting sustainable utilization of ecosystems
	by transmitting and encouraging access to Knowledge and technology for farmers at affordable prices, along with the use of digital technology.	the impacts of climate change, replace the declining workforce and enter an aging society along with the utilization of space technology and geo-informatics, digital technology.

4.2 Drive and Promotion of Smart Farming from Relevant Sectors

In order to get in-depth information relevant to the drive and promotion of Smart Farming from relevant sectors, the researcher was kindly granted interviews via Zoom program with 6 officials from the government agencies, 1 from state enterprise, 3 from the private sector, 1 from public organization, and 1 from academic institution as follows:

4.2.1 Government Agencies

4.2.1.1 Queen Sirikit Department of Sericulture, Ministry of Agriculture and Cooperatives

Thailand places importance on Smart Farming. Mr. Chalermchai Sri-on, Minister of Agriculture and Cooperatives delivers the policy and introduces the Action Plan on Smart Farming 2022-2023. The government's Thailand 4.0 Policy and the 20-Year National Strategy formulated the Master Plan on Agriculture and the Minor Plan on Smart Farming under the Strategy to increase competitiveness. Ministry of Agriculture and Cooperatives implements the policy to drive the smart farming that expects to upgrade the quality of life of farmers by using technology to

support the production process of agricultural goods, shift of current agricultural pattern to Agriculture 4.0 by using innovation and technology to develop smart farming of the future.

Queen Sirikit Department of Sericulture promotes and supports Smart Farming in urban community such as promotion of sericulture production, sales of cocoon, production of quality silk, preparation of silk for weaving handicraft, and hand-woven silk which is appropriate to the conditions of urban community especially silk weaving and silk weaving with the Royal Peacock Logo which is the activity that can be undertaken in the households of farmers in urban community. There is monitoring of the profession of sericulture Smart Farming by compiling information of sericulture Smart Farmer every year and analyzing to assess the progress of practicing profession according to the competency of all sericulture smart farmers.

“Queen Sirikit Department of Sericulture organizes the survey of quality of life of sericulture Smart Farmer for the budget year 2022 onward according to the public sector management quality of the Department, with the topic of income and expenditure in everyday life as well.”

4.2.1.2 Department of Fisheries, Ministry of Agriculture and Cooperatives

Department of Fisheries has the personnel with knowledge, understanding, and expertise in Smart Farming, as well as Smart Farmer's close learning from real experience with Smart Officer being coach to Smart Farmer. Department of Fisheries developed Smart Farmer between 2017-2020 which held upgrade the quality of life of the old generation of farmers as well as motivate the next generation to increasingly turn to farming.

Department of Fisheries was assigned the policy to implement the project to develop Smart Farmer between 2017-2020 through the support, promotion, and knowledge to farmers to have knowledge, skills, and ability for practice the profession of fishery across the value chain of production in line with livelihood and characteristics of the profession of each person with focus on applying the knowledge and information relevant to decision-making, use of technology, local wisdom, best

practices, and in line with international principles ensure that farmers take pride in being farmers and are sustainably self-reliant.

“Department of Fisheries promotes and develops personnel to have knowledge and create workforce with high competency who can be lecturers to transfer agricultural technology of Smart Farming to farmers and interested people.”

4.2.1.3 Cooperative Promotion Department, Ministry of Agriculture and Cooperatives

The Department still lacks the personnel who can directly serve as lecturers on Smart farming. It can only invite successful farmers in particular areas as lecturers to exchange knowledge from real practice in order to learn from the successful farmers such as the project of farmers’ offspring to return home and continue farming profession.”

Farming support is rendered in Bangkok Metropolitan Region as well as cooperatives near provinces or district offices for organic farming such as mainly organic crops and vegetables for sales to consumers in the city to save transport costs and maintain the quality of fresh crops in response to consumers’ demand. Policies and measures are put in place to promote Smart farming in urban community by focusing on cooperatives or farmer groups to be ready for the urban environment to replace land with higher costs and promoting the production of agricultural products that create high value such as organic farming, smart farming using principally greenhouse which can give high yields to farmers.

“The Department still lacks the personnel who can directly serve as lecturers on Smart farming. It can only invite the successful farmers in particular areas to serve as lecturers to exchange learning and real practice to stimulate good example such as farmers in the project of farmers’ offspring to return home and continue farming profession.”

4.2.1.4 Department of Agricultural Extension, Ministry of Agriculture and Cooperatives

The personnel have sufficient knowledge and understanding Smart farming to promote farmers for the development of Thailand’s agriculture to move towards modern agriculture by using the technology of Precision agriculture, Geoinformatics technology, smart farming machinery, as well as internet technology to

connect equipment and tools (Internet of Things or IoT). But some fields requiring specific expertise, technology, and innovation may need proper and appropriate advice from experts.

Department of Agricultural Extension has the project of 1 District 1 smart farming plot. The activity to promote and develop the pilot smart farming was first operated in the budget year 2022. Initial information is compiled for the practice of Smart farming to give advice to farmers for decision-making but may not cover all activities of the main crops as the project has just been allocated budget for the first year and in the process of operation.

“If Smart Farming in urban community is concretely promoted, the first priority may have to consider the cost-effective aspect in applying technology and innovation in agriculture in urban community. Compared to suburban areas, the transport is better and creates the highest return in investment.”

4.2.1.5 Rice Department, Ministry of Agriculture and Cooperatives

Rice Department has advanced information on Smart farming that farmers can access to information with the ability to request information at Thailand Rice Science Institute or Information Technology Center of Rice Department accompanying the decision-making relatively well such as information on rice varieties and rice seeds.

Rice Department has no policy on Smart Farming in urban community. Mostly it is Smart Farming with rice plots of farmers as the mission of the Department will focus on the promotion and assistance to farmers to produce good quality rice seeds, reduce costs, and increase output. The Department has no support on Smart Farming in urban community as the context of urban community does not facilitate large rice cultivation.

“Rice Department has up-to-date information on Smart farming that farmers can have access to. They can request information at Thailand Rice Science Institute or Information Technology Center of Rice Department to accompany decision-making relatively well such as rice varieties and rice seeds.”

4.2.1.6 Agricultural Land Reform Office, Ministry of Agriculture and Cooperatives

Agricultural Land Reform Office supports farmers in the land reform areas in their acquisition of knowledge on G.A.P. and supports them to be certified with the agricultural good standards in the land reform areas. It also supports organic farming through the project to promote organic farming in the land reform areas to create value to products or output with the process of education and learning, implementation in the local area, as well as support of budget and knowledgeable and able personnel to go on field trips and give all support to farmers.

The Office has no support of Smart Farming in urban community as the operating areas of Agricultural Land Reform Office has no area in urban community. But the areas in the land reform areas are developed for knowledge. There is support of Smart Farming which is appropriate to particular communities such as water control through Smart Phone, use of drone, use of agricultural machinery, and plant cultivation in greenhouse, etc.

“Personnel of Agricultural Land Reform Office both at the central administration and 72 provinces can act as lecturers for other agricultural technology transfers and knowledge on Smart Farming and can provide advice and coordinate with other network agencies with knowledge on Smart Farming or other agricultural fields that the farmers in the land reform areas wish to learn.”

4.2.1.7 Summary of the drive of Smart Farming by government

The guideline to drive and promote Smart Farming in the opinions of government agencies is as follows:

- 1) The areas for Smart Farming in urban community are limited. Farmers cannot expand the land in line with the market demand due to excessively high land costs and most of the land is also fast developed into residential areas.

- 2) Specific location or area should be arranged for the practice of Smart Farming in urban community to prevent impact from pollution and uncontrollable environment.

3) Motivation for urban residents to turn to Smart Farming includes cost effectiveness, and toxic-free goods, etc. The support is also needed from the clear and continuous government policies.

4) There is still shortage of knowledge on Smart Farming for residents in urban community and it is hard to have access to it. Mostly, there is platform or application that is suitable for farmers with large plots of land and readiness in terms of capital than farmers in general who are poor.

4.2.2 State Enterprise

4.2.2.1 PTT Public Company Limited

PTT Public Company Limited is Thailand's power company that is privatized from Petroleum Authority of Thailand by merging 2 of the state's energy organizations namely Thai Fuel Organization and Thai Natural Gas Organization. It operates the business of integrated natural gas and petroleum. It was ranked Thailand's state enterprise with the highest income in 2012.

Smart Farming PTT Innovation for Happiness Project. It is the innovation and technology for new agriculture aiming to develop social business in the field of new farming by applying international innovation and technology management and increased income from production capacity, reduced costs, working time, and increased community output with modern agriculture such as hydraulic ram pump, underground water bank, wastewater treatment system, solar cell system in community and greenhouse, biogas, drone for agriculture, IoT, high quality plastic for green house, and nano zinc oxide.

4.2.2.2 Recommendations for the guideline to drive and promote Smart Farming in the opinions of the state enterprise are as follows:

The use of technology that is appropriate to the farmers' work in parallel with the farmers' existing knowledge will serve as the crucial step towards successful Smart Farming. Currently, many farms start to apply the technology by using various tools to control and manage the farms such as precision system to provide waste and fertilizer. There is no longer any need to guess the amount of

fertilizer. Tools or sensors are used to control temperature, humidity, pH conditions, and soil richness to be able to respond more efficiently to cultivation.

Nowadays, hi-tech facilitating equipment is easy to buy at affordable prices. Although agricultural innovation is still rare and expensive, in the future with continuous development and support from the government, Thailand's agricultural technology will be developed to be surely on a par with other countries in terms of increased income and output for farmers. Moreover, the focus is on environment, water, soil, optimal resource utilization, reduced use of chemicals, focus on initial safe farming before further developing into safe farming. The government's development and cooperation policies will ensure farmers' strength and sustainable development with higher economic competitiveness.

4.2.3 Private Sector

4.2.3.1 Advanced Info Service Public Company Limited

From the past experience, AIS operates the Digital for Thai Project by complementing technology and knowledge to the industrial sector in Thailand with the continuous stress on the importance of the country's agro-industry. As a consequence, AIS continuously works with farmers to develop the technology to help them as Corporate Social Responsibility (CSR), including Mobile Application of happy farm shop as a channel for distribution of agricultural goods, community enterprises, and online OTOP, as well as knowledge sharing among farmers.

The concept of AIS iFarm is to develop the common platform on the cloud to compile information, conduct analysis, and automatically order IoT equipment to ensure that farmers can adjust their land into Smart Farming. This can be undertaken by installing the sensor and set the initial value without having to develop any program by oneself which is easy to work with and reduce the time required by the farmers to learn technology, with focus on learning and understanding of information to best improve cultivation. The principle of AIS iFarm is one of AIS's efforts in driving the 5G vision to the business sector in all industries to ensure that Thailand is competitive in terms of applying the technology, innovation, and connection of 5G with the business and that business operation is efficient, with

information to accompany every decision-making, and flexibly use automatic system for work.

4.2.3.2 Siam Kubota Corporation Co., Ltd.

“Kubota Farm” derives from the application of knowledge on integrated agricultural innovation which is specific to Kubota or Kubota Agri Solution (KAS) to the 10 zones on the land of 220 rai in Chon Buri designed under the development concept from upstream to downstream. It receives cooperation in terms of R&D from both the public and the private sectors as a pilot farm to transfer knowledge to farmers who will learn to use machinery and agricultural solutions.

Siam Kubota aims to develop the solution to cover all of farmers’ needs from upstream to downstream, as well as processing, increase output value, and connection with buyers or market, development towards high value farming, modern precision farming, and holistic economic development or BCG Model. Kubota Farm is the prototype to transfer knowledge to farmers and other communities towards sustainable development or UN SDG, as well as support the government projects to develop smart farming through cooperation from all sectors, including the public and the private sectors, academic institutions, and farmers, and ready to be a major drive to support smart farming in Thailand, eradicate farmers’ poverty without leaving any one behind, and drive Thailand’s agricultural economy towards sustainable growth.

4.2.3.3 Guideline to Drive and Promote Smart Farming in the Opinions of the Private Sector is as follows:

- 1) The government should promote the clear and concrete Smart Farming policy such as empty space in urban community uses knowledge from the university research to develop model farm for farmers and interested public to come, learn, and train to become successful smart farmers.

- 2) The Smart Farming technology is relatively expensive. Most of interested farmers do not have easy access to it. They still practice agriculture that relies on the weather, resulting in a lot of output loss every year. But if the government supports the use of Smart Farming technology for farmers with appropriate and inclusive prices, it will have good impact on the farmers’ agricultural practice and create the security of the country’s economic system.

4.2.4 Public Organization

4.2.4.1 Agricultural Research Development Agency (Public Organization)

Agricultural Research Development Agency (Public Organization) was established under the supervision of Minister of Agriculture and Cooperatives with the Royal Decree to set up Agricultural Research Development Agency in 2003 and started operation since March 15, 2003 with the initial capital of approximately 3,000 million baht from the agricultural and personnel research development fund, Ministry of Agriculture and Cooperatives. The objectives of the establishment of the Office include the following: promote, support, develop agricultural research, and personnel development on agricultural research; study, research, and dissemination of information and IT on agriculture; academic cooperation with academic institutions or other public and private institutes to produce and develop research and domestic and international agricultural researchers; the center to provide the services of agricultural information and IT from study, research, and development; connection with academic institutions and other relevant domestic and international agencies to promote academic activities to disseminate knowledge in various forms such as publication of documents, audio-visual, seminar, workshop, exhibition, or other operations relevant to dissemination of agricultural knowledge. The Agency formulates the action plan to upgrade the grassroots agriculture by using Smart Farming; the strategy to upgrade society and sustainable development; solutions to problems and timely adaptation for the dynamic of global changes by using science, research, and innovation to develop the grassroots economy; poverty eradication and reduced inequality; upgrading of Smart Farming with complete value chain in the community; innovation development which is a mechanism or system that promotes and strengthens the grassroots economy that is really practical in cooperation with government, local, and private agencies in the area; creation of personnel network in the area with the role and ability to apply or transfer knowledge, research works, technology and innovation to develop the grassroots economy in order to create the environment and mechanism to support and develop the local economy, upgrade the connection of the supply chain to become the value chain with the use of resources, culture, local wisdom, profession creation, and widespread income distribution to communities.

4.2.4.2 Guideline to Drive and Promote Smart Farming in the Opinions of the Public Organization as follows:

Smart Farming is a new form of agriculture that uses high precision technologies with importance placed on consumer safety, environment, and optimal resource utilization. In the age where the number of agricultural work force has decreased over the years, the agricultural sector needs to adapt itself by applying technology to increase production efficiency. The main composition of smart farming requires 3 dimensions which will ensure its efficiency namely identification of the cultivation areas, data analysis in line with the duration of plant cultivation, and area management using appropriate technology without excessive use of resources and consistency with the cultivation of specific plants.

4.2.5 Academic Institution

4.2.5.1 Kasetsart University

At present, Kasetsart University offers the course on Smart Agriculture System Plants Production Entrepreneur. The course is destined for entrepreneurs of smart farming with focus on the production of personnel to create and apply the innovation of smart farming to drive Thailand 4.0 policy as well as support alternative or new profession after the crisis of the spread of COVID-19 pandemic to people in various groups such as independent professionals, laid off labor force in the system/returned workforce, unskilled labor force in the system with trend to decrease, currently valuable labor force but requires Upskill/Reskill, labor force entering the system, etc. This course focuses on students' practice and work with farmers to understand the needs of workers, create innovation for practical use, and joint analysis and solving problems. When the students finish the course, they will have knowledge, skills, and confidence to work immediately in the agricultural sector in Thailand.

The course stresses practice by enabling students to think and do during the first week of the course. All subjects will have the case studies or projects which are the integration of all subjects in the particular subject set to be able to design and develop smart farming that is appropriate to plant cultivation both in greenhouse and agricultural plot, as well as business skill to be the Smart Agriculture

System Plants Production Entrepreneur who must have the ability to analyze and identify the factors impacting plant production, design, and development of control system with microcontroller for greenhouse and agricultural plot, assessment of the level of factors impacting quantity and quality of agricultural yields, preparation of expenditure plan and production costs to decide on the installation and system development.

The Policy and Action Plan of Smart Farming 2022-2023 of Ministry of Agriculture and Cooperatives from the Thailand 4.0 policy and the government's 20-Year National Strategy determine the master plan on agriculture and minor plan on smart farming under the competitive strategy of which the Ministry has the policy to drive smart farming with the aim to upgrade farmers' quality of life by using technology to support production process of agricultural goods, adjust the current agricultural pattern to move towards Agriculture 4.0 by focusing on the use of innovation and technology to develop towards smart farming in the future. The main goal is to practice little agriculture for high output, most efficient use of resources in production, reduce costs, reduce loss, increase production efficiency, reduce hardship of workers in the agricultural sector, use of modern machinery and tools especially digital agriculture in production process to increase productivity and competition of Thailand's agricultural sector in the world market. As for the formulated action plan on smart farming, it will chart the direction of smart farming and lay down the systematic foundation of the country's smart farming. The relevant agencies under Ministry of Agriculture and Cooperatives and other agencies including the public, the private sectors and farmers can apply the framework of the project proposal under the action plan on smart farming to the agencies' project proposal to drive the country's smart farming. Moreover, it accelerates personnel development in agencies both central and regional to be ready for R&D on smart farming, promotes government officials and farmers to really implement it, and serves as coach or trainer to farmers by focusing on Smart Farmer, Young Smart Farmer, and farmer leader of Agricultural Productivity Efficiency Increasing Learning Center and big plots. It is expected that large plots of smart farming will be concretely developed in every province in the country and in every district in 3 years to ensure concrete results in accordance with the goal of the National Strategy on agriculture. Ministry of Agriculture and

Cooperatives places importance on the drive of Thailand's agricultural sector with science and technology and appoints the Committee to drive the policy of agriculture with the composition of Subcommittees in 4 fields namely 1) Subcommittee to drive Big Data and Gov Tech 2) Subcommittee to drive smart farming 3) Subcommittee to drive e-commerce, and 4) Subcommittee to drive agricultural business to upgrade farmers' quality of life relying on technology, innovation, and marketing to drive the operation towards Agriculture 4.0.

Operation is undertaken to drive the master plan under the National Strategy on agriculture and the goal at the issue level with increased GDP from agriculture and increased rate of agricultural productivity. At the minor plan level, it involves local agricultural identity with higher value added, safe farming with higher value added, Thailand's products from safe farming are certified with quality, safety, and higher nutritional value, bio farming, growth of GDP of increased special border economic zones and increased investment of special border economic zones, processed agricultural products with higher value processed agricultural goods and products, smart farming with higher value goods from advanced/smart technology, increased output per unit of farm or plot with the use of advanced/smart technology, development of agricultural eco-system with increased efficiency of production of agricultural products per unit, farmer institutions (cooperatives, community enterprises, and target groups) registered with Ministry of Agriculture and Cooperatives with higher efficiency and standards. According to the information of smart farming, the goods from advanced/smart technology have higher value. More output per unit of farm or plot using advanced/smart technology. The value below the critical target and the value reaching the target increase value in quantity and quality which results from the operation according to the plan from the government's promotion policy, which Ministry of Agriculture and Cooperatives has concretely formulated the action plan on smart farming 2020-2022.

4.2.5.2 Guideline to Drive and Promote Smart Farming According to the Opinions of the Academic Institution as follows:

1) Research on Smart Farming: At present, the government formulates the policy on budget for academic work. There are relatively

a lot of research works but the farmers cannot readily apply them. They are rather suitable for government agencies to adapt into pilot farm or demonstration farm. The research is expensive and rather complicated to use. At present, the university's work is divided into 2 parts namely academic work conducted directly for the government requiring relatively high budget with expensive equipment and training for farmers which are relatively advanced and inexpensive.

2) At present, academic institutions attract interest from the private sector by supporting capital for universities to organize trainings on Smart Farming for farmers or supporting capital for academic research. It is joint academic development between the private sector and the university.

4.3 Gap Analysis of Implementation of Relevant Policies, Strategies, and Plans

Gap Analysis is to analyze the situations which are the gaps between the goals according to the development goals, connection between the milestones and the main goals of the 13th Development Plan and the National Strategy (2018-2037) Goal 1 Increased the value added of agricultural products and processed agricultural products, Goal 2 Develop the basic infrastructure and management system for quality, food security, and agricultural sustainability, Goal 3 Increase the potential and role of agricultural entrepreneurs as economic partners of the supply chain with appropriate and fair benefit, as well as policies and plans of relevant agencies. Which the government has improved the standard Up-to-date laws and regulations Fair and conducive to policies to promote smart farming (Smart Farming) in urban communities and management. Legal measures to promote smart farming have already been established. But it appears that there are still gaps in the implementation of the policy. Related strategies and plans are as follows.

1) Agricultural products of smart agriculture (Smart Farming) can control the production process factors to meet quality standards and safety without worrying about weather conditions, different from the products obtained from traditional agriculture that have to depend on the weather As a result, it can yield continuously every season. make the value or price of the produce Smart Farming

products have a high price. The government should set clear policies and strategies to promote continuous and consistent production processes. And consistent marketing, especially online marketing, to be able to increase more income for smart agriculture (Smart Farming).

2) Production of smart agricultural products (Smart Farming) to meet the needs of specific market segments. or consumer groups will result in more value-added products because the production process can control the amount of product production to achieve quality Safety and good standards in the required amount appropriately, such as producing products for business units directly to hospitals, hotels, restaurants, restaurants, etc.

3) Creating a smart agricultural product brand (Smart Farming) in order to increase competitiveness and create opportunities to access the market. The government should promote and support Smart Farming entrepreneurs in giving importance to production using the market as a leader. And taking into account the needs of the market, especially in high-value markets. as well as developing a clear strategic plan for accessing large potential markets.

4) Product development to increase the value of smart agricultural products (Smart Farming) The government should formulate policies and strategies in bringing agricultural products to add special characteristics or some outstanding features to be different from the original in order to better meet the needs of consumers. climb Smart Farming: Techniques should be developed to add value by processing or preserving food to increase the value of the product so that the price is higher than before. Which, if done systematically, will result in the production of agricultural products in excess of the market and can also reduce the production cost of the product as well Because most of the agricultural products that have been processed are smaller than the normal size. This reduces transportation costs from production to distribution.

5) Productivity of smart agriculture (Smart Farming) The government should focus on the production process that is environmentally friendly. Good Agricultural Practices (GAP) is a production system that allows the use of agricultural chemicals. Chemical fertilizers in the production process must be used in the correct amount according to the recommendations of the Department of

Agriculture. Ministry of Agriculture and Cooperatives which will produce agricultural products that, when harvested There may be a low level of toxic residues, but it is safe for consumers.

4.4 Success Factors of Smart Farming

In order to achieve the in-depth information on Smart Farming in urban community from the farmers who constituted the model case studies, the researcher was kindly granted the interview based on the structured interview with 10 key informants and with study tours. The details were as follows:

4.4.1 Hydroponics Vegetable Farm, Amphawa Subdistrict, Amphawa District, Samut Songkhram

Mr. Wonganan Sukcharoenkana is the owner of Chokanan Farm and pioneer of hydroponics vegetable farm for export to Europe. Mr. Wonganan graduated with B.A. degree in engineering, Kasetsart University, M.A. degree in communication electricity from Colorado University at Boulder, USA, and Ph.D. in nanotech from Canada. He currently runs 2 businesses namely hydroponics vegetable farm, and processed sea food. The turning point in his career to pioneer a hydroponics vegetable farm is the trend of currently popular organic vegetables. Upon decision to practice organic farming, the first thing to do is to seriously undertake study, training, and study tours in the field, including cultivation methods, technology, and search for market or regular business partners. In 2017, the crisis faced by exporters included insects and insecticide as farmers did not have closed greenhouse. So, he turned crisis into opportunity by running hydroponics vegetable business which required diligence, and perseverance in learning to ensure that production would yield premium products in parallel with the search for market in view of support prior to investment in vegetable cultivation, the practice of which exporters respond to this business model.

According to Mr. Wonganan, the business perspective is to solve problems. If the problems are solved, business will take place by using market-led production, and not cultivation first before selling to customers. If there is no order, there is no cultivation.” Later, Mr. Wonganan started to invest in the first phase of a hydroponics

vegetable farm on an area of approximately 2 rai. As for the phases 2 and 3, the cultivation method used the substrate culture on the land of approximately 3 rai with investment capital of over 10 million baht, excluding land prices. The latest technology from Israel was applied in the closed greenhouse system, focusing on cleanliness, standards, and attractiveness. Foreign visitors regularly make study trips in order to be reassured of quality. At present, in 2022, he has approximately 26 greenhouses and investment is expected to pay back within four years.

4.4.1.1 Success Factors of Smart Farming

Mr. Wonganan is a businessman who invested in the farmer profession without any prior knowledge on farming. He is only committed to succeed in agricultural profession. He is ready in terms of capital and able to use the IT equipment in order to plan marketing. Mr. Wonganan is diligent in seeking additional knowledge in the farmer profession through attendance in trainings organized by various government agencies. He is also well supported by government agencies to develop the management system within the farm to meet the correct standards. The farm is certified with the safety standard at the Global G.A.P. level so that the output can be exported to foreign modern trade markets. The IoT equipment is also used in the farm for watering, fertilizer, and control of pests, the control of sensor system to check the temperature, and better identification of the spread of insects. Moreover, he records, prepares income-expenditure account to know the costs, benefits of operation, as well as analysis of the records and statistics to plan the cultivation that meets the demand of customers, and the output can be totally sold.

4.4.1.2 Application of Innovation or Production Technology



Figure 4.3 Closed Greenhouse in The Plant Factory

Note: Hydroponic Vegetable Garden Amphawa Subdistric, Amphawa District, Samut Songkhram Province

Prior to start undertaking hydroponics vegetable farm, Khun Wonganan seriously undertook study and sought knowledge on the topic, including cultivation methods, technology, and marketing, or regular partners. He applies the knowledge and experience to the farm starting with the greenhouse, control of light, water, fertilizer through the control and pesticide system using the IoT technology.

The technology used for the farm management is the closed greenhouse of the Plant Factory as shown in Figure 4.3 It is considered agricultural innovation towards sustainability. It also facilitates farmers in various aspects, including reduced costs and time, increased efficiency in production process more than traditional farming, able to control the factors of the plants' growth, environment, water, fertilizer, light, appropriate temperature and humidity as in Figure 4.4 Off seasonal plants can be cultivated. Farmers do not have to worry about

the weather and insects which constitute the main reason that the quality and quantity of output do not meet the target. Moreover, the Internet of Thing (IoT) system is also used in the farm for water, fertilizer, and control of pests, control of sensor system to check the temperature, better identification of the spread of insects, reduced costs of chemicals and control of insects for better quality and accuracy as in Figure 4.4

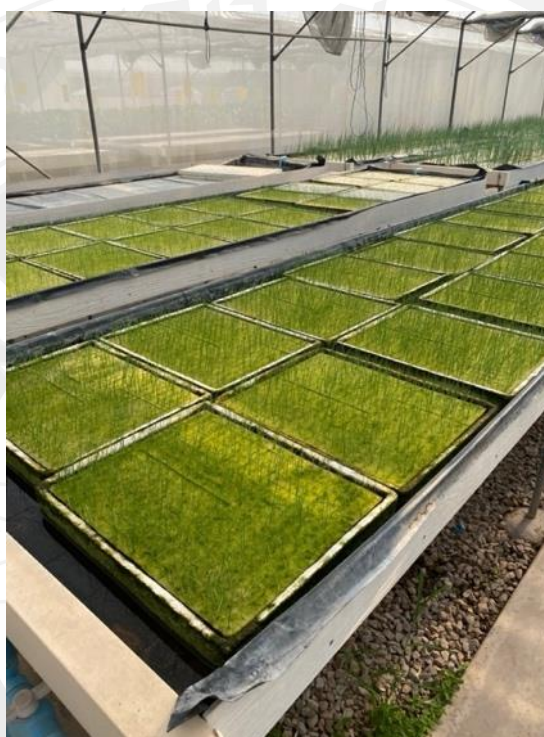


Figure 4.4 Picture of Placing the Seedling Tray in a Tray That Can Drain Water from the Bottom.

Note: Hydroponic Vegetable Garden Amphawa Subdistrict, Amphawa District, Samut Songkhram Province

4.4.1.3 Management

Production process: Daily inspection of the quality and cleanliness of water and adjustment of water quality for appropriateness, the greenhouse with appropriate environment for production, academic-based and proper use of fertilizer, use of microbial pesticide to control pests in the plot.

Output management: All kinds of hydroponic vegetables in the farm meet the quality and the standard of Global G.A.P. The quality of the vegetables is of

premium quality and ready for export to foreign modern trade markets. There is recording of information of the use of fertilizer and the spraying of chemicals to ensure accountability if problems arise, as well as recording of information of costs, and output sold each time.

Marketing management: Prior to cultivation of any vegetable, there must be orders from abroad first before starting cultivation. The farm will not start the cultivation first and wastes its time in searching for markets. The output is exported to Switzerland, Germany, and UK.



Figure 4.5 An Interior Image That Controls Light and Temperature to Suit Plant Growth

Note: Hydroponic vegetable garden Amphawa Subdistrict, Amphawa District, Samut Songkhram Province

Khun Wonganan has good access to information of Ministry of Agriculture and Cooperatives, various institutions, and organizations through IT and other communication channels through Smart Phone. Moreover, there are systematic

recording, accounting, information of customers, and statistics of monthly sales of salad. The information can be used to analyze and plan the cultivation of each type of vegetable in response to the demand of market and customers. The recorded information can also be used to solve problems and improve his profession. For example, he uses the monthly orders from foreign customers to plan cultivation in each cycle requiring approximately 45 days, in accordance with the quantity and quality of the Global G.A.P. standard in response to the demand of customers, and efficiently reduce the problems of unsold goods in the stock.

4.4.1.4 Enhancement on Success

There is transfer of knowledge on agricultural profession for the benefit of the surrounding community in Samut Songkhram. Samut Songkhram Provincial Agriculture and Cooperatives Office and Department of Agricultural Extension, Ministry of Agriculture and Cooperatives organize the activity for farmers interested in hydroponics farming to undertake study tours of the farm operation. Moreover, various universities bring B.A. and M.A. students to come and study the cultivation of hydroponics vegetables. Khun Wonganan acts as the lecturer to give knowledge based on real experience starting from the strong and weak points of plant cultivation using the NFT (Nutrient Film Technique), factors affecting the growth of plants using the NFT, and demonstration of hydroponics cultivation of salad using the technique of NFT. Moreover, he cooperates with Assoc. Prof. Dr. Thammasak Thongket, Department of Horticulture, Faculty of Agriculture, Kamphaeng Saen Campus, Kasetsart University, who is the expert on vegetables and hydroponics system under the condition of “Protected Cultivation” to produce clean vegetables with the standard of controlled condition to give lectures to farmers and the interested public on hydroponics farming. The activity requires reservation in advance as it limits the attendees due to the farm’s closed system in order to control hygiene, spread of diseases and insects, as well as temperature and light appropriate to the growth of plants.

4.4.1.5 Determination in Agricultural Profession

“I want to undertake the hydroponics farming certified with the Global G.A.P. safety standard which is the standard of good agricultural practice recognized worldwide. The main principle of the retail trade in the current market is

the demand of reliable standard to ensure that the goods come from sustainable and safe agriculture. The Global G.A.P. standard is recognized at the highest level in the field of sustainable and safe farming. Therefore, the compliance with the GLOBAL G.A.P. standard is similar to the passport that will take producers to the global market. The major standard of GLOBAL G.A.P Integrated Farm Assurance provides certification of the standard of production of 3 types of goods namely cultivation of plants (edible plants including flowers and ornamental plants), husbandry, and aquaculture.”

4.4.1.6 Conclusion

Khun Wonganan is a businessman who invested in farming without any prior knowledge on farming. He is only determined to succeed in agricultural profession. He can use IT devices to help plan marketing. He is diligent and perseverant in looking for additional knowledge by attending trainings held by various government agencies. He is also well supported in the development of the farm’s internal management based on standard and accuracy and his farm is certified with the Global G.A.P. safety standard. The IT devices are used in the farm. Moreover, he makes recording, prepares the income-expenditure account to know the costs, profits in operation, as well as the use of recorded statistics to analyze and plan cultivation and he is successful in the agricultural profession as intended and desired.

4.4.2 “Melon & Salad Farm” Allocation of Half of The Land for Digging Pond, Khlong Jed Subdistrict, Khlong Luang District, Pathum Thani

Mr. Weerapong Su-osot, the second generation of the owner of “Uncle Daeng’s Melon & Salad Farm” said, “His family has succeeded so far thanks to the gracious assistance of His Majesty the Late King Bhumibol Adulyadej who granted them the land of 8 rai. The family has used the land for agriculture from his father who started the farming down to himself as in Figure 4.5



Figure 4.6 Bird's Eye View of “Uncle Daeng Melon & Salad Farm”

Note: Melon & Salad Farm Khlong 7 Klongluang District Pathum Thani

Similarly to general farmers, he started with the cultivation of both paddy and tree crops. But in the past, he faced many problems, including marketing, insects, and natural disasters, causing damage. He did not give up and was determined to solve problems to create new opportunities. He was so diligent in learning so that he was supported by Pathum Thani Agricultural Land Reform Office to start the profession of cultivating melons and salad. Until 2013 after graduation, he started to work in a company. But as he was interested in farming and he liked challenges, he experimented on cultivating melons in parallel with his regular job. At first, the cultivation was undertaken outdoor. The first cycle yielded abundant output. But in the following cycle, the insects started to cause trouble. Almost all output was damaged. So, he started to think of a greenhouse for cultivation. He had to rethink everything because cultivation in a greenhouse is different from outdoor especially for soil formula or fertilizer formula. He continued to study by himself until he acquired his own formulas. When everything was in order, in 2015, he resigned from work and became a full-time farmer.

Later, he started to consider the melons which required 3 months before harvest. He also grew salad as a supplement while waiting for the melons because the salad took only one month to grow. Then, he further grew tomatoes as a supplement because they took only 2 months to grow. As a result, by 6 months, there was output for him to pick and sell every day. As for the mulberry grown along the

fence, it could always be picked for sale. So, the farm continuously generated income. The first greenhouse was 6.30 meters wide and 20 meters long. The first investment was 65,000 baht for the cultivation of 400 melons. The money from the sold melons was used to invest in the second greenhouse. He now owns 10 melon greenhouses, 2 salad greenhouses, and 1 tomato greenhouse. The plot was arranged for continuous cultivation to ensure continuous output and sufficient for the demand. People started to come for study tours of the farm as followed from the social media. So, the idea occurred to him that, as a new generation, the smart farm system should save costs, labor costs, and time to produce output for sales. The farm is successful and has turned into a learning center for interested people nationwide. It cooperates with Department of Agricultural Extension and Agricultural Land Reform Office-Pathum Thani, Ministry of Agriculture and Cooperatives, to set up a network center as in Figure 4.6. Agricultural Productivity Efficiency Increasing Learning Center is the source of creativity, innovation, and incubator for farmers and provides agricultural services to upgrade farmers towards entrepreneurship and sustainable agricultural community as a center for transfer of production technology, management and marketing for farmers, agricultural services, and dissemination of local information and news to serve as a mechanism to integrate work of various agencies to solve problems and develop agriculture in the area.

4.4.2.1 Success Factors of Smart Farming

Khun Weerapong's family practiced farming since the generation of his parents. So, Khun Weerapong received transfer of skills and knowledge in agriculture since he was young. Nowadays, Khun Weerapong is a new generation of farmer with the conviction to practice the profession. Moreover, he can use IT devices very well, in terms of search for additional knowledge, public relations, and online marketing to sell the farm produces. Apart from diligence and perseverance, he has also attended trainings and study tours organized by the government to provide knowledge to farmers and received budget support from Hydro-Informatics Institute (Public Organization) to assist in the automatic farm control system. The IoT devices are used to send warning from the smart phone screen on the information of water level, greenhouse temperature, and greenhouse humidity. In terms of production, Khun Weerapong knows and understands the G.A.P. standard well. The farming

guideline includes good quality output in compliance with the standard, cost effective high output, safe production process for farmers and consumers, consumption of resources for maximum benefit, agricultural sustainability without generating pollution in the environment. Moreover, he is also able to process output from the farm to reduce loss and increase value to the products such as melon processing into melon ice cream where customers can sit at the farm which is open as restaurant or the customers can do takeaway. The agro-tourism is also arranged for many customers to visit the farm atmosphere and buy goods and services.



Figure 4.7 Board of Agricultural Productivity Efficiency Increasing Learning Center and Network of Agricultural Land Reform Office (Uncle Daeng's Farm), Khlong Luang District, Pathum Thani as the Center of Transfer of Production Technology, Management, and Marketing for Farmers, as well as Agricultural Services

As the farm has good water management, Hydro-Informatics Institute (Public Organization) supports the automatic farm control system with special quality. Not only can it control temperature, air, humidity in the air and the

soil, automatic spraying of water, fog, drug, and automatic air ventilation but it can also compile information from wireless sensor in parallel with meteorological information from satellite, model of weather, to be processed in order to improve the planning of cultivation in the next cycle where everything can be controlled, information can be sent, and warning can be given through smart phone or tablet.

Khun Weerapong has a very interesting notion on the sacrifice of half of the land to dig a pond to use the water for the farm as in Figure 4.7 “Most of those who grow vegetables in the irrigated area ignore water because they think that they can draw water from the irrigated canal all year round. Digging a pond will always waste space. But they forget that sometimes there may be contaminants in the canal which may damage the vegetables. Sometimes, there is the surge of sea water. So, I decide to use half of the land from the total of 8 rai to dig a pond of 2-3 meters deep and 10-12 meters wide. The pond will surround the area in the form of the letter L to store water for my own use and for breeding of tens of thousands of fish. The pond has been dug for 4 years. And I never have to draw water from the outside to use in the farm.”



Figure 4.8 Water Management by Digging Pond with Support from Hydro-Informatics Institute (Public Organization)

4.4.2.2 Application of Innovation or Production Technology

Khun Weerapong uses the smart farm system to save costs, labor costs, and time. As the farm has good water management, Hydro-Informatics Institute (Public Organization) supports the automatic farm control system with special quality. Apart from the control of temperature, air, humidity both in the air and in the soil, as well as automatic spraying of water, fog, drug and air ventilation, it can also compile data from the wireless sensor with the meteorological data from satellite, model of weather, processing to be able to improve the planning of the cultivation in the following round where everything can be controlled, information can be sent, and warning can be sent from smart phone or tablet.

4.4.2.3 Management

In terms of cultivation, the focus is on the use of advanced technology, the IoT system for management, quality output, and importantly safety from toxic substances according to the policy of safe food of G.A.P. that encourages farmers to produce safe agricultural products according to the quality management system.

In terms of water used in the farm, in the past, the canal water was used. But sometimes there may be some contaminants in the canal during the surge of sea water damaging vegetables. So, Khun Weerapong decides to use half of his land from the total of 8 rai to dig a pond of 2-3 meters deep and 10-12 meters wide to surround the area in the form of the letter L to store the water for his own use and feed tens of thousands of fish. After the pond has been dug for 4 years, he does not have to draw water from outside to use in the farm.

Khun Weerapong can efficiently gain access to knowledge provided by Ministry of Agriculture and Cooperatives, institutes, and organizations through the IT system and other communications via Smart Phone. Moreover, there is systematic recording, income-expenditure account, detailed information of customers, as well as statistics of the sales of salad and melons every month and can use the information to analyze planning of each type of vegetable in response to the demand of market and customers. The recorded information is also used to solve problems and develop his own profession. For example, in the beginning with cultivation of melons outdoor, the first cycle yielded high output. But in the following cycle, there was the problem of

insects which damaged nearly all output. Then, he analyzed the recorded information and turned to closed greenhouse in controlled condition. He started the entire cultivation process because indoor cultivation is different from outdoor cultivation especially soil and fertilizer formulas, as well as undertook additional studies and finally came up with his own formulas and led to his success in 2015.

4.4.2.4 Enhancement on Own Success

From the success today, cultivation in greenhouse focusing on the cultivation of melons, watermelons, salads, mulberries, and others is transferred to interested people from all over the nation. A lot of interested people come to learn about the various processes of cultivation and harvest, as well as creation of supporting market. Khun Weerapong's door is wide open for every one and he is ready to fully transfer knowledge. In cooperation with Department of Agricultural Extension and Provincial Land Reform Office-Pathum Thani, Ministry of Agriculture and Cooperatives, they set up the Agricultural Productivity Efficiency Increasing Learning Center on the occasion of his being a successful farmer and role model for farmers and the interested public to come and learn about the real farm and real practice in the learning plots and receive appropriate agricultural technology transfer to serve as information for successful agricultural profession in the future.

4.4.2.5 Determination in Agricultural Profession

“The principle of market-led production will draw buyers to the farm by opening it as an agro-tourism destination. The result is that not only visitors are happy with tourism in their free time, they are also customers who come to buy output from the farm both fresh produces and processed products, including various food items such as salad. Therefore, this location creates market, increases value of the farm output, and greatly reduces the process and transport costs. Moreover, it also serves as the learning source for members of the Agricultural Productivity Efficiency Increasing Learning Center so that Khun Weerapong can efficiently undertake technology transfer on production, management, and marketing to the members, as well as services provided on agricultural information and news.”

4.4.2.6 Conclusion

The strength of Khun Weerapong's Melon & Salad Farm is that it has received good feedback from customers and young people of the new generation.

Melons used to be imported and were quite expensive. When it is possible to undertake domestic cultivation, The prices are lower and the farm attracts a lot of interests from those who appreciate the taste of melons. The success factor of Smart Farming is the support of land from Agricultural Land Reform Office by setting up the Agricultural Productivity Efficiency Increasing Learning Center in the area of land reform. The government places importance on the increased efficiency of the production of agricultural goods by focusing on agricultural learning center in community to transfer knowledge on agriculture to community and provide services of information, news on agriculture. At the same time, the present situations of agricultural production of farmers face the problems of high production costs, diseases and insects, and lack of rich soil yielding low output quantity and quality. Most farmers face the problems of business loss, with debts, and lack of self-reliance. Ministry of Agriculture and Cooperatives by Department of Agricultural Extension set up the Agricultural Productivity Efficiency Increasing Learning Center which serves as the community's agricultural learning center to solve community's problems, respond to the agricultural needs of the community, and serve as the tool of agricultural promotion by stressing the learning from the model farmer who is successful in increasing efficiency of production of agricultural output.

4.4.3 Suanlungthod Banana Orchard” 43 Moo 5, Nong Sam Wang Subdistrict, Nong Suea District, Pathum Thani

Khun Theerapong Suksawang or Khun Tum residing at 43 Moo 5, Nong Sam Wang Subdistrict, Nong Suea District, Pathum Thani is a Young Smart Farmer who turns his interest in preserving rare and valuable banana varieties. Apart from spiritual value, the preservation of quaint banana varieties substantially generates supplementary income for Khun Tum. He graduated with M.A. degree in chemical engineering from Kasetsart University. After graduation, he had the opportunity to work in his field of education for 3-4 years. He had to resign from work to take care of his aged parents. The members of his family have the background in farming. His parents grew oranges. But after some time, the orange orchards in Pathum Thani faced crisis. Oranges died from disease. So, his family turned to grow and sell decorative plants such as temple tree, sealing wax palm as supporting trees instead.

Until 2011, he and his parents turned their interests to quaint and rare banana varieties. It started from his neighbor. The reason that Khun Tum was interested in quaint banana varieties was partly because his neighbor was a seller of trees and often had some quaint banana varieties which sold well. Khun Tum was interested and started to ask information. He was given approximately 4-5 quaint banana varieties to experiment on cultivation. During that time, the neighbor's business was growing so it stimulated him to do so as well. So, he asked the neighbor to sell him additional quaint varieties. Afterwards, he started the collection from 2011 up till the present, he collected over 100 varieties. He is currently one of the three sellers of the most unusual and the rarest banana varieties. After starting the collection of various unusual varieties, he started to see his own marketing channel. He started his own marketing. The strength was to deliver the varieties to customers by post. The feedback was quite good. Until 2017, he started to expand to the cultivation of Cavendish bananas and Ducasse bananas by dividing 3 rai for the cultivation of Ducasse bananas and 1.5 rai for the cultivation of Cavendish bananas. As he started to see the gap for the only sale of banana shoots, the generated income was not constant. He could not determine the number of shoots and the number of orders. The sales of output were foreseeable as the day of the yield and the volume of the yield could be calculated. But the sales of banana shoots must wait for customers to come and buy. Some months, he could sell only in the thousands of baht and some months in the tens of thousands of baht. As the income was not regular, he chose to cultivate both banana varieties for security. The sales of output would be the main income whereas the unusual varieties would be good supplementary income. He also was diligent and perseverant in learning.

4.4.3.1 Success Factors of Smart Farming

As his family had the background in traditional farming since the days of his parents, they faced the problems of natural disasters, epidemics, toxic substances from insecticides, and debt burdens. Down to the generation of Khun Tum, he had the opportunity to learn about the farming experience from his parents since he was a child. Nowadays, Khun Tum is resolved to succeed in the farmer profession. He is the new generation of farmer who uses the guideline of Smart Farming. He can use IT devices to seek additional knowledge, plan marketing for

public relations by using modern marketing channels via Facebook to attract interested customers or farmers to inquire about the information and details of banana shoots through Messenger. Customers can wire the payment of the banana shoots via a bank's Application. The banana shoots will be delivered via EMS of Thailand Post and transport of general private companies. Statistics and information are recorded such as the monthly sales of banana shoots, the income-expenditure account, the demands of customers in order to plan the cultivation in accordance with the demands of customers. Khun Tum's agricultural business with the collection and cultivation of over 170 banana varieties then propagation for sales is extremely interesting with low competition in the market.



Figure 4.9 Atmosphere in the Banana Orchard with Over 170 Banana Varieties

Among the various fruits, banana is considered the fruit tree that requires simple care and cultivation. It is also the fruit tree that is useful in its entirety. It is therefore not difficult for farmers to turn to the cultivation of bananas as

it is not difficult to find the market. Khun Tum is yet another farmer who seriously takes interest in bananas but not as the owner of the banana orchard who grows and sells the bananas. Khun Tum looks into more fundamental issue which is the propagation of banana varieties for sales which requires easier care and yields more regular and higher income. At present, it is the business that not many farmers are interested in doing or competing for customers. Khun Tum's strong point is that he is ready with over 170 banana varieties as in Figure 4.9

4.4.3.2 Application of Innovation or Production Technology and Sales

As for the tips in cultivation, the knowledge is transferred from the parents who practiced the profession of farmers for over 50 years by cutting the bananas into a hole of 30 cm wide and 30 cm deep or less deep for 1-2 cm. In general, bananas can be grown in nearly all types of water-holding soil. To ensure good output, bananas should be grown in loose soil as they grow well in the soil and the quality of bananas should be taken into account as well. To ensure sustainable banana cultivation, the best should focus on the richness of the soil and the water - storing quality of the soil. After growing bananas for 1-2 months, he would use the fertilizer formula of 16-16-16 for approximately 1 fistful/time, and approximately 30 cm away from and around the trees. For the water system in the cultivation of bananas, there is the lifting of bed and the watering by boat all the time without causing waterlogging. Soil will be observed. If there is humidity, there is no need for watering. When it starts to be dry, then the watering will be done as usual."

Khun Tum uses the online sale channel with interested customers through Facebook platform and conversation channel in Messenger to sell banana shoots. Once the transaction agreement is reached, the money will be transferred via the bank's Application at the customer's convenience. The banana shoots will be delivered via EMS of Thailand Post or transport of private companies such as Kerry, etc. The sales of goods via the online channel and transport system is to appropriately meet the demand of customers. It is the innovation that benefits the farmer profession by getting rid of middlemen and the prices of the agricultural products are not cut, and the process of production and sale management is reduced.

4.4.3.3 Management

Khun Tum started the conservation of unusual banana varieties from 2011 until the present. He collected over 170 varieties. Khun Tum says that the collected unusual banana varieties are mostly from the neighbor and additionally by himself. The difficulty in preserving the unusual banana varieties is not only the rarity but sometimes for the same banana variety it is called differently depending on provinces or regions. Sometimes, when he exchanges a variety with someone who is not expert, he will get the same variety back or will be cheated. So, he recommends to buy at the known and trusted farm. The output from cultivation for cutting and selling of banana shoots takes only 6-7 months and 1 tree can be dug for sale with the output of approximately 5-8 shoots depending on the completeness of the shoot and the variety. For example, plantain has a lot of shoots with 2 rounds around the tree or approximately 20 shoots. But not all shoots are perfect. If any shoot is imperfect, it will be cut off to keep the strong ones.

In terms of care for diseases and insects, shoots are selected from the beginning. The opportunity for diseases and insects will be minimal. There is a small amount of spraying of insecticide or no spraying at all if there is no worry of output. There will be a lot of diseases and insects during the budding of banana trees and the harvest. If left in this manner, the tree will rot and quickly causes diseases and insects. This needs to be swiftly managed by digging up the tree and disposing it far from the orchard or burning it which will greatly reduce disease-carrying insects. The support of the banana tree depends on the weakness of each banana variety. For example, the Ducasse banana is relatively strong and does not require the support. But the Cavendish banana requires the support when the banana blossom starts to shoot or aged approximately 6-7 months. Moreover, the support is required when the banana tree starts to bear fruit and tends to fall.



Figure 4.10 The Atmosphere in the Banana Plantation Improves with Good Water Management

Khun Tum uses the Smart Phone to search for news and knowledge on agriculture and distribution channels for the banana shoots. Moreover, he regularly participates in trainings organized by government agencies and is lecturer to transfer knowledge to students who come to study the cultivation of various banana varieties. He also records, prepares income-expenditure account, detailed information of customers, as well as systematic recording of statistics of the monthly sales of bananas. He uses the information to analyze the planning of the cultivation of each type of banana in response to the demand of the market and the customers. The recorded information is also used to solve the problems and develop his own profession.

4.4.3.4 Enhancement on Success towards Community's Learning Source

At present, Khun Tum's banana orchard is a demonstration plot of learning and study tours for institutions offering B.A. and M.A. degrees. In the future, he wishes to develop and generate more income from his existing unusual banana varieties. But he may need to cooperate with experts to conduct research on

the strengths of each variety of bananas and the possibility of processing or utilization.

In terms of providing knowledge on the banana cultivation, Khun Tum will focus on the correctness of varieties from the digging of shoots, positioning before growing each banana variety to the cultivation process. During the cultivation process, he can determine the direction of the banana blossoms by turning the cut shoot in the opposite direction of the desired banana blossoming. For cultivation, he puts the root in the hole, completely covered with soil. He steps tightly on the covered soil so that there is no gap between the soil and the banana root. Then, he waters abundantly and covers with straw or dry grass.

The land totals 12 rai. Khun Tum divides half of the land or 6 rai to grow bananas with 4 plots. He grows only each variety for 2-3 plots each time so that every 2-3 years there will be alternating cultivated area. As banana is not perennial, it is necessary to move the plot and prepare the soil to alternate the cultivated area. If it is grown in the same plot, the output will not be very good. For example, the plots were recently damaged by the storm and over 10 collected varieties were affected. As he could not prepare the additional plots on time for the cultivation, the original 187 varieties were reduced to approximately 170 varieties.

“For current banana cultivation, most farmers grow bananas to harvest almost all banana output. But at the farm, we think that it is better to sell banana shoots. Because for the cultivation of bananas to collect the banana shoots, with appropriate water and fertilizer management system, he can collect the shoots every month. One banana tree will yield the output of more than one shoot. If he cultivates bananas for the output, one banana tree will yield only one bunch of bananas and can be collected only once per one cultivation for the period of 1 year or for some varieties probably more than 1 year. Comparatively, the number of the acquired shoots will certainly exceed one bunch of bananas.”

4.4.3.5 Determination in Agricultural Profession

“In the future, I want to develop and generate more income from the existing unusual banana varieties.” Presently in 2022, Khun Tum manages to collect over 170 rare banana varieties which is the strength recognized by many other farmers wishing to grow bananas and becoming his customers.



Figure 4.11 Strong Family Bonds Serve as an Encouragement for Farmers in their Agricultural Pursuits

4.4.3.6 Conclusion

As Khun Tum's family has the background of farmers from the generation of his parents down to Khun Tum who has had the opportunity to study, learn, and experience the farmer profession from his parents since he was a child, Khun Tum is highly determined to succeed in the farmer profession with the guideline of Smart Farming by using IT devices to seek additional knowledge, planning of marketing for public relations, recording of statistics and information, preparation of income-expenditure account, and recording of customers' information and needs. Khun Tum's business of collecting as many as 170 banana varieties for propagation of shoots for sales is very interesting due to low competition in the market. The success of Khun Tum's Smart Farming is extremely interesting. The farmers who are ready in terms of other plant varieties apart from banana can learn the success factor from this example for their own profession.

4.4.4 “Suanpanisara” Dates and Gimju Guava, 99/1 Moo 8, Nong Kai Subdistrict, Kratumban District, Samut Sakhon

In the past, grapes, mangos, dragon fruits, and lemons were grown. At present in 2022, they are replaced by guavas, with the guava varieties of Golden, Kimju, and Red Kimju. The repeated cultivation of the same type of plants will reduce output. It is recommended to practice rotation. The guava tree is 4-5 years old. But if the chemical fertilizer is used, the tree will be only 3 years old. Khun Petch’s method is semi farming between organic and chemical farming or bio farming, with focus on greatly reduced production costs, safety for growers and consumers, product safety, and not exclusively on organic farming. Because the context of the farm is not appropriate due to the location of the farm. Adjacent farms all use chemical fertilizers. The solution is to try to reduce the use of chemicals by using bio and chemical fertilizers during the outbreak of worms and aphids by using ‘bio fertilizer’ instead of manure, stable manure, cow droppings, quail droppings, with focus on roaming cows instead of cows bred in the farm due to the contaminated hormones and food leavening agents in the cow droppings.

The characteristics of soil in Khun Petch’s farm is new soil with a lot of mixed minerals. In the past, the local people used to practice paddy farming. Later, they turned to grape orchard by ridging similarly to exposing the soil in the sun so that the upper soil is dry and loose which is suitable for cultivation due to the presence of minerals. As for the water, it will flow down to the ditch. The use of bio fertilizer only from roaming cow droppings will help maintain rich soil. For the business of Khun Petch’s orchard, the main players are Khun Petch herself and her mother. Her father is very advanced in age and no longer helps in the orchard. There are also 2 temporary workers.



Figure 4.12 Khun Petch is Proud and Happy with her Career Success in Smart Farming

Suanpanisara has the total area of 24 rai from the former area of 20 rai. Khun Petch rents additional 4 rai of land for the experiment of integrated farming system. As for part of the knowledge, apart from trainings organized by Ministry of Agriculture and Cooperatives, Khun Petch receives knowledge from YouTube. The VDO is on pollination, and bending of the bough. Khun Petch's farm is at an advantage due to loose soil. Dates are grown with bananas, mangoes, coconuts, and rose apples instead of monoculture like in other orchards. It is rich in the ecosystem. She is also determined to learn. At present, in 2022, it has been five years that she has started to grow dates and sell them. Khun Petch starts to receive tourists to the farm based on agro-tourism. As a result, Khun Petch generally earns from agricultural practice of over 30,000 baht a month.

At present, Khun Petch starts the business of eco-tourism. She charges the entrance fee of 50 baht per person. She offers fruits for tasting, and welcome drink. Fruits can also be gathered with the price at the farm gate similarly to the wholesale price. Other activities include making dried flowers, guava cakes, and guava juice.

4.4.4.1 Success Factors of Smart Farming

Khun Petch is a female fruit grower who follows the footsteps of her parents as her role models. She is a dedicated person and determined to succeed in the farmer profession. She can use the IT devices to seek knowledge that will develop and enhance on her profession, efficiently plan marketing, including online marketing, public relations of goods, output and services to interested customers via Facebook. Khun Petch is enthusiastic in regularly attending trainings held by the public and the private agencies to provide knowledge on successful agricultural practice. She records statistics and information, clearly and systematically prepares income-expenditure account. She can process and sell the farm's various types of output. The farm's output is certified with the G.A.P. standard with focus on production process that yields safe output, lack of pesticides, and quality that meets the customers' satisfaction. Farmers are grouped for cultivation in big plots supported by Department of Agricultural Extension, Ministry of Agriculture and Cooperatives. The farmers are encouraged to group themselves for cultivation of guava in big plots and become successful. It inspires Khun Petch to start agro-tourism business to facilitate the customers who want to experience the atmosphere of agricultural garden.

4.4.4.2 Application of Innovation or Production Technology

Based on the semi agricultural practice which is the combination between the use of chemical fertilizer and organic fertilizer, the health of all family members is better. For example, she uses Trichoderma, green tea extract to prevent root rot and stem rot diseases, metabolism to get rid of beetles, milk hormone as supplement made from milk to prevent wastewater, and better quality of life for everyone. The share of the use of chemicals at present is reduced to approximately 50%. Because in one year, the "bio fertilizer" or fertilizer from roaming cow droppings is used for 5 tons in the farm of 20 rai. "The strong point is that we can use the fertilizer as much as we like because it will not destroy the plants." Khun Petch's farming requires planning. Before starting work, from production, products, customers, connection, methods, and system, she will look into her own guideline, including recording of everything to compare the changes of growth of the cultivated plants in the farm.

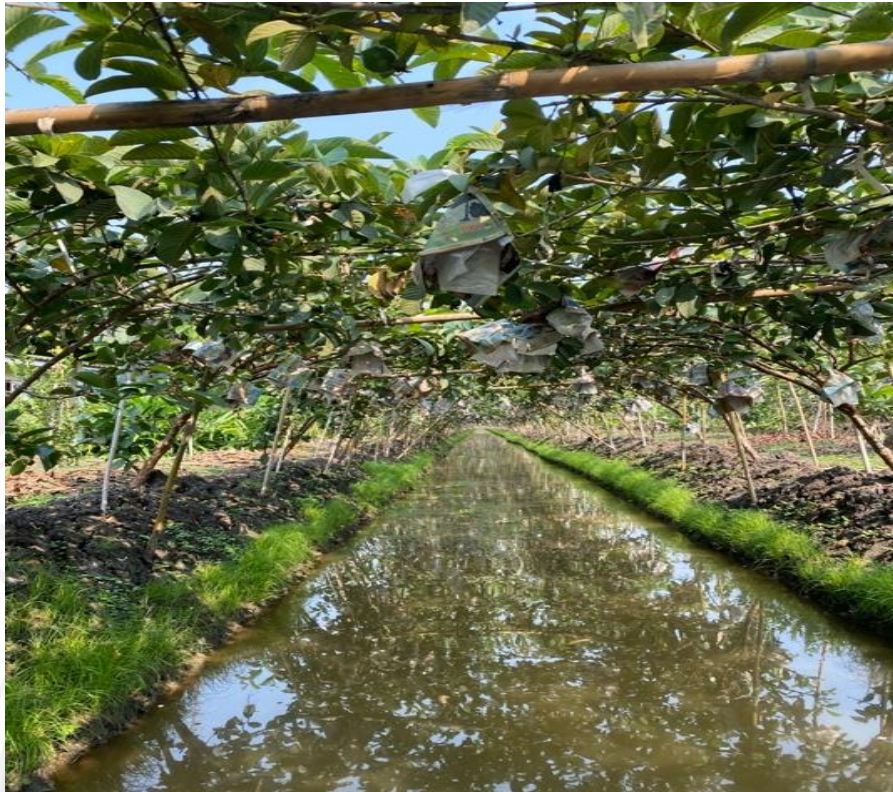


Figure 4.13 The Shady Atmosphere of the Guava Garden and the Irrigation Canals Help in the Production of Crops During the Dry Season

Khun Petch makes use of online media, and Facebook platform to communicate and make public relations about the output from the farm in each period to customers and interested persons. The output is for sale to the customers who visit the agro-tourism at the farm and to those who order online. Khun Petch delivers goods through the transport channel of the EMS services of Thailand Post in speedy response to the needs of customers and also helps expand the market to customers nationwide. The farm output can be sold at cost-effective prices without residue or waste.

4.4.4.3 Management

Khun Petch is knowledgeable and experienced in agricultural practice and self- learning. She serves as lecturer and gives good advice to farmers interested in growing dates, bananas, mangoes, coconuts, and rose apples. She is the chairperson of Nong Nok Khai community enterprise supported by Department of Agricultural Extension, Ministry of Agriculture and Cooperatives to encourage

farmers to turn to guava cultivation in big plots replacing former cultivation of grapes, mangoes, dragon fruits, and lemons. At present, in 2022, they work together in guava orchard, including varieties of guava such as Golden, Kimju, and Red Kimju. The repeated cultivation of the same type of plant will decrease output. Therefore, rotated cultivation is necessary.

Khun Petch can gain access to information sources from the government agencies who come to provide additional knowledge on the cultivation of guavas and dates through Smart Phone. Moreover, she uses online media through Line and Facebook programs. She creates a page called “Suanpanisara” as a channel of marketing and public relations for customers. It greatly increases the sales. She records information and uses it for analysis and planning prior to operation. She also manages output in accordance with the market demand.

Khun Petch is able to manage output and marketing well, in terms of production to the wholesale Si Mum Mueang Market and plan production in response to the demands of the market and the consumers during festivals, as well as sales of fruits to retail customers who come and experience the way of life of fruit growers at the same special prices as the wholesale prices. Khun Petch organizes agro-tourism activities and invites customers to visit the orchard and buy output and processed products from the orchard such as guava cake, guava juice, dried dates, etc.

4.4.4.4 Enhancement on Own Success

Khun Petch's farm is one of the members of Nong Nok Khai community enterprise. In the past, the farmers grew guava, used fertilizer and a lot of chemicals but output decreased. There was also the health problems and sickness due to the use of chemicals. The production costs were high and the investment was not cost-effective. Later, Department of Agricultural Extension supported them to form group and grow guava in big plots, reducing production costs. They also had more bargaining power with dealers. Afterwards, the group was interested in processing the output with unattractive outward features. They processed the guava into spicy dried guava which helped increase the group's income. As farmer groups and visitors started to come for study tours, the group realized that it could extend the activity to agro-tourism. So, they started to set up agro-tourism group from the base of local farmers working in big plots and nearby networks. Khun Petch was elected

chairperson. Moreover, Khun Petch's Suanpanisara is also a place of study tours for students at B.A. and M.A. degrees from various academic institutions.

In the competition for startup business plan of Bansomdejchaopraya Rajabhat University in 2022, Suanpanisara's Guava Waste business plan for tie dye fabric from guava leaves was awarded the first prize. Moreover, the red guava jam from Suanpanisara community enterprise was certified with the Q Mark and G.A.P. standards. The quality of guava consists of a lot of antioxidant substances to slow down age and reduce wrinkles, and increase immunity. But the income from the activity is less than sales of fruits from the orchard.

4.4.4.5 Determination in Agricultural Profession

“Khun Petch wants Suanpanisara to succeed as agro-tourism destination apart from success in growing various fruits. It is the source that is ready to deliver agricultural knowledge and happiness and enjoyment for all family members. The agro-tourism intended by Khun Petch is the tourism that focuses on the learning of fruit growers' way of life, and the participation of tourists as in Figure 4.9 Agro-tourism will focus on activities of agricultural learning and ways of life, culture, tradition, and use of existing resources to create learning, benefiting and generating income for the community and the farmers. The concept of agro-tourism requires the appropriate development of agricultural land to ensure sustainable agricultural sector by connecting the agricultural sector and community lifestyle with tourism in order to enhance value and competitiveness, leading to preservation and promotion of the sustainable agricultural development. It promotes the farmers to have alternatives, increase income, instill appreciation and pride in their culture, lifestyle, and profession, impacting succession and preservation of agricultural profession in the long run. At present, agro-tourism is very popular because tourists can experience agricultural lifestyle, proximity to nature, local uniqueness, and importantly, it is tourism with learning approach, appropriate to people of all genders and ages, especially those who come for relaxation with family.”

4.4.4.6 Conclusion

Khun Petch is proud to be a farmer which is the profession inherited from her parents who were farmers in the past and the agricultural land in the present. Khun Petch loves and cherishes the land and the agricultural profession that she will

pass on to her daughter in the future. Nowadays, Khun Petch lives happily and is satisfied with farming profession. The major factor that Khun Petch succeeds in Smart Farming is that she is eager to regularly seek additional knowledge from Social Media and trainings and seminars organized by government agencies who provide knowledge on farming and marketing channels, including the online media Facebook in publicize the activities of Suanpanisara to continuously reach the target groups.



Figure 4.14 Tourists Visiting Suanpanisara in the Form of Agro-Tourism

4.4.5 “Pitak Mushroom Farm” 45 Moo 5, Tha khai Subdistrict, Mueang Chachoengsao District, Chachoengsao

Mushroom culture is considered a very popular profession. Especially in the health-conscious market, mushroom consumption is very popular. Mushroom is food without fat. One does not get fat how much one consumes it. Mushroom is a unicellular plant of the fungus family. It is a source of natural protein, rich in vitamins and nutritional value, with medicinal properties. It promotes immunization, reduces rate of risks from serious diseases such as coronary artery disease, high blood pressure, diabetes, etc. At present, mushroom is found to have high economic values.

Those who practice mushroom farming earn a lot of money in all regions in Thailand. For mushroom farming, the knowledge on nursery management is also important as it contributes to the availability of mushroom for sale all year round.

When starting mushroom farming, Khun Pairoj was lucky that he had regular job although he did not have to go to his office every day. So, he had more time to study and find information on additional occupation until he came to mushroom. In the past, Khun Pairoj experimented by buying and cultivating mushroom spawn, the flowering did not yield the output that was as good as it should be. In the end, Khun Pairoj tried to make the spawn by himself. In the beginning, he failed and he did not dare use it himself. After trial and error, he became confident. He used it and succeeded. He knew that good spawn required good raw material. Khun Pairoj used rubber wood sawdust ordered from the south as rubber wood had more nutrients than other woods such as rice bran. Khun Pairoj used steaming, good sterilization, and correctness in all process. "When the spawn is good, the environment is good, and there is no insect pest, the mushroom will survive. The acquired mushroom has good quality. It is also plump, and beautiful."

During the first 5 years, it was the struggling period because the money was heavily invested but there was no return and there were many problems, nearly bankruptcy. But problems required solutions. Although one problem was solved, another one arose. He had to solve problems all the time but he never gave up.

After 5 years of diligent and perseverant learning, everything started to stabilize. The cultured mushroom started to yield return. The company that Khun Pairoj worked with started to be more secure. Everything returned to normal. But Khun Pairoj decided to practice mushroom farming full time. After resigning from his regular job, Pitak Mushroom Farm started to be more secure. Khun Pairoj practiced mushroom culture and made spawn himself. The return included mushroom, and spawn culture, as well as mushroom processing. Moreover, when the spawn started to expire, it will be used as fertilizer. He could also grow lemons for sale. It can be said that today Khun Pairoj transforms everything in the mushroom farm into money.

Khun Pairoj's outstanding mushroom is Korean grey oyster mushroom because it can be grown all year long in every season. It is resistant to the environment, heat, and insects. Its flowering is better than other types of mushrooms.

It tastes better, and it is better than the old one in every way. After the cultivation of the mushroom, Khun Pairoj managed to stand firm after struggling and managed to build his future. At present, Khun Pairoj expands mushroom nurseries, markets, and sells a lot of spawn, followed by mushroom, then fertilizer. In the future, he will expand to a dome for mushroom culture. A new law is issued on the stipulation of agricultural product standards, practical guideline in using the standard of agricultural products, and practice on mushroom cultivation. According to the Agricultural Standards Act B.E. 2551 (2008), it is necessary to build a control lab based on the format of the Food and Drug Administration as the standard format.

4.4.5.1 Success Factors of Smart Farming

Khun Pairoj started his farmer profession through seeking knowledge from government agencies who organized trainings. Khun Pairoj is a determined person. He seriously learns, implements, tests, and evaluates himself. So, his experience is directly accumulated which is better than classroom learning alone without implementation. Moreover, he can also use the IT devices to seek additional knowledge. He uses the knowledge to plan marketing and online marketing, advertisement and public relations for sales of goods and services. He is also diligent in seeking additional knowledge on agriculture for himself by attending trainings and seminars held by public and private agencies. He uses the IoT tools to provide water and fertilizer with the mushroom cultivated in the farm to reduce labor and material costs and working time. He records statistics and information. He systematically prepares income-expenditure account. Khun Pairoj's mushroom farm can produce safe mushroom certified with the G.A.P. standard in accordance with farming to acquire output with good quality and safety according to the standard. The production process must be safe for farmers and consumers without chemical contamination or pollution in the environment, maximum use of resources to gain high output which is cost effective for the investment. It also generates agricultural, environmental, and economic sustainability.

4.4.5.2 Application of Innovation or Production Technology

Khun Pairoj had his degree in engineering. He likes to learn and experiment new things on a regular basis. During the first year when he started mushroom farm, the problem of the cleanliness of the mushroom spawn was the main

reason of mold, resulting in mushroom that did not have quality. So, Khun Pairoj invented and developed the steaming machine for mushroom spawn as in Figure 4.10. It is neatly designed. The roof is curved to prevent the clinging of water. Below in the machine there is a water container and above there is an iron beam to place the grill to steam mushroom spawn. There is a thermometer to gauge the temperature. It is convenient to move the spawn in and out. It is easy to work on and enables the output to have the quality in accordance with the demand of consumers. In addition, he invents the compressor of material from rubber wood sawdust for mushroom spawn cultivation to be used in the farm as well.



Figure 4.15 Steaming Oven of Mushroom Spawn Invented and Developed by Khun Pairoj to Steam the Raw Material Used of Mushroom Spawn Cultivation for Cleanliness

4.4.5.3 Management

Khun Pairoj uses knowledge and experience from experiments and self-learning for over five years for mushroom cultivation, both retail and wholesale, including production of spawn to be used in the farm. The production of mushroom

spawn to be used in the farm . The production of fertilizer from the expired spawn is used for the cultivation of lemons and processing of mushroom juice for sale.

Khun Pairoj operates marketing via Facebook under the name of Pitak Mushroom Farm for public relations as an intermediary for the distribution of goods to the interested customers.

Khun Pairoj can gain access to information from officials of Ministry of Agriculture and Cooperatives who give additional knowledge on good mushroom farming through IT and he can efficiently use online media through Smart Phone on production and marketing.

Khun Pairoj is highly capable of managing the factors of production. He can choose the raw material that yields good output such as the good spawn production requires good raw material by using rubber wood sawdust ordered from the south because rubber wood has many nutrients compared to other woods. In terms of labor force, instead of hiring regular worker, Khun Pairoj uses the method of lump sum per work piece to produce the mushroom spawn with the pressing machine of material from rubber wood sawdust as in Figure 4.11, resulting in reduced costs, quality work piece, and able to sell to customers with lower prices. Moreover, Khun Pairoj plans production with Zero Waste Management without useless waste from production.

For example, the expired mushroom spawn will be processed into fertilizer to grow lemons.



Figure 4.16 Pressing Machine of Materials from Rubber Wood Sawdust for Mushroom Spawn Cultivation Invented by Khun Pairoj for His Own Use

Khun Pairoj's income comes from numerous sources, including the sales of mushroom, mushroom spawn, fertilizer from mushroom spawn, and processed products. For mushrooms, merchants from the weekend market will come and take them away for sale. The farm will charge the price of 60 baht a kg. The merchant will sell them at 80 – 100 baht a kg. For mushroom spawn, local farmers will regularly come to buy them. Khun Pairoj has done it all. He used to think of quitting. When the local farmers come to buy the mushroom spawn at Khun Pairoj's farm, they earn profit so they keep coming back and become regular customers. They are mostly old customers of over 3 years. Khun Pairoj never abandons his customers. Pitak Mushroom Farm will always produce mushroom spawn with good quality to customers. As for processing, he processes lingzhi into fried mushroom, deep fried mushroom in sweet and salty sauce, etc. Moreover, at present, after deducting costs, Khun Pairoj earns approximately 60,000 baht (Sixty thousand baht) a month. Khun Pairoj is very happy with the return of every month.

4.4.5.4 Enhancement on Own Success

In the future, Khun Pairoj has the project to expand his farm to Surat Thani, his wife's old hometown. Khun Pairoj went to survey the market there. The market is good with high demand in mushrooms, the raw materials are easy to find, the weather is good and suitable for mushroom farming.



Figure 4.17 Khun. Pairoj is Very Proud and Happy with the Income and Rewards of His Career as a Smart Farming

4.4.5.5 Determination in Agricultural Profession

Khun Pairoj's knowledge on mushroom cultivation is acquired from learning online, learning from District Agricultural Extension Office, additional learning at Chiang Mai University once a year until the lecturers trusts him to represent them by providing knowledge to the residents in Chachoengsao and adjacent areas. Khun Pairoj does not keep all these knowledge and experience to himself. He opens the farm as a learning center for those who are interested, mostly from Department of Agricultural Extension or other agencies who contact him. It is also a mushroom learning center. Office of the Non-formal and Informal Education,

local administration organizations, and schools send people and students in groups for study tours of the farm, including spawn production, various types of processing such as fried mushroom, fermented mushroom, deep fried mushroom in sweet and salty sauce. For those who wish to undertake or enhance on the activity, Khun Pairoj is determined to drive the interested farmers to succeed in the profession of mushroom cultivation like himself who has succeeded.

4.4.5.6 Conclusion

Khun Pairoj started the Smart Farming “Pitak Mushroom Farm” by seeking additional knowledge by himself. He started by attending trainings and seminars held by government agencies, academic institutions, and universities who open training courses on mushroom culture and use the knowledge to improve, develop, and enhance on the knowledge without giving up in the face of hardship for over 5 years before meeting with success. Once successful, he is happy to share technological knowledge to farmers and those interested in the profession of mushroom culture to study, learn, and implement with Khun Pairoj without risking losses, unlike trial and error experienced by Khun Pairoj. His success in the farmer profession is applaudable. He also thinks of sharing the knowledge on mushroom culture to farmers and interested people as well.

4.4.6 Products under the brands “Lertphol Riceberry” and “Lertphol Thai Pathumthani Fragrant Rice”, 26 Moo 1, Mahasawat Subdistrict, Phutthamonthon District, Nakhon Pathom

He is the model farmer in the field of production of organic rice. He becomes farmer following his parents’ footsteps. As his father is old, he assigns all 6 of his children to bear the responsibility instead. Khun Chaisri is the youngest son. During his time, his father practiced only rice farming. But Khun Chaisri practices integrated farming. In the past, the only practice of rice farming was relatively complicated. He started by growing the Khiew Sawoey mango. After some time, he found out about the problem that with the mangoes grown on the garden plot, its roots would find food with difficulty. They were not grown like in a farm or in a general mango orchard. They also yielded a small amount of output. The age of the *Khiew Sawoey* mango with the maximum harvested output is approximately ten years. After consulting with

his wife, he decided to cut down all the mango trees and turned to rice farming. The rice variety was Gai Tawng Kum rice. Usually farmers grow it by using the tractor to plow paddy rice provided by local investors. The investors bring the rice variety for free and at the same time provide the tractor free of charge as well. Once the output comes out as unhusked rice, the investors will buy it back. Khun Chaisri will take care of his paddy plots by himself. The high or low return of the output depends on care and dedication. The output will be higher than rice from paddy-sown field. Because for the field where the seeding rice is transplanted, the investors will select the rice variety that yields high output. After a while, when the tractor owners suspended operation, Khun Chaisri could not continue by himself due to old age so he turned to riceberry rice farming.

He started to grow riceberry rice in the paddy field of 6 rai in 2016 by buying the rice grains from Kamphaeng Saen District, Nakhon Pathom. In the beginning, Khun Chaisri's objective was to grow the rice to consume by himself. The rest would be sold. The cultivation takes only 120 days before harvest. It is natural agricultural practice without chemicals. It turned out to be relatively successful. The concept of Smart Farming is also interesting in terms of environment. Khun Chaisri thinks that what one gets from nature, one has to give back. For example, for riceberry rice, there is no burning or taking out. After harvest, Khun Chaisri will leave the straw in the field without burning it but leaves it to degrade into fertilizer, while waiting for rice cultivation in the next cycle.

Khun Chaisri uses the guideline to work on organic farming as profession without chemicals for cultivation of two varieties of organic rice namely riceberry rice and Thai Pathumthani Fragrant Rice 1 in compliance with the nine regulations for organic rice until he was certified with the standard of the production system of organic rice from Rice Department. There are three scopes for the certification namely cultivation source of organic rice, processing of organic rice, and packing of organic rice for production and processing of organic rice for sales to consumers. He was coached by official from Rice Department. The production of organic rice reduces production costs. When the organic rice is produced, it can be processed into packed milled rice for sale in the market as well. Apart from processed rice, riceberry rice can be processed into riceberry rice ice cream and

young coconut ice cream. It is yet another channel to earn income. Consumers are very interested in organic rice as it is forbidden to use chemicals in the whole system. Bioextract is used instead of chemicals. Buffer zone is set up around the area of rice cultivation to ensure that the output of organic rice is truly safe. He earns income on a daily, monthly, and annual basis. External and internal buffer zones are set up. The external buffer zone consists of vegetables that generate daily income to be sold at the market. Khun Chaisri advises general farmers to turn to the cultivation of organic rice which not only generates income but also reduces production costs and is safe for producers and consumers.

4.4.6.1 Success Factors of Smart Farming of Khun Chaisri Loonlertpol

Khun Chaisri exercises the farmer profession following his ancestors. His parents were his role models. He is determined in the farmer profession. He can efficiently use the IT devices to seek knowledge and plan online marketing. He is interested in new technology. He regularly attends trainings and seminars on the advancement of the farmer profession. He is supported by the government sector, Provincial Energy Office-Nakhon Pathom, Ministry of Energy as in Figure 4.12. For the construction of the rice mill, the energy from the solar cells is used to mill the riceberry rice as processed product to customers. Khun Chaisri's riceberry rice is certified with the G.A.P. standard. The G.A.P. for rice is the implementing standard that specifies the details of the regulations on the management of the necessary production process for the G.A.P. taking into account environment, safety, and welfare of the farmers to ensure that the output has quality, that the output is safe and free of pests, suitable for consumption, and has the quality that satisfies consumers.

4.4.6.2 Application of Innovation or Production Technology

Khun Chaisri uses the concept of organic farming to improve the methods of producing the riceberry rice, efficient production process, reduced production costs, development of rice quality to be certified with organic standards, value-added and output through integrated processing and sales.

Khun Chaisri invited many local farmers to jointly grow riceberry rice. When the members increased, there was the problem of the rice mill. Because if

they brought the riceberry rice in two 2 fertilizer sacks with the weight of approximately 60 kg. at the rice mill, the mill would not accept to mill it. Most would accept only white rice. Except if there was a large amount of combined output, then the rice mill would accept to mill the output. So, Khun Chaisri set up his own rice mill as in Figure 4.13 and provided the service for members and the general public at the milling fees of 4 baht a kg. At present, he charges 3 baht per kg with the discount of 1 baht for farmers. Khun Chaisri was supported with the budget of 478,000 baht (Four hundred seventy-eight thousand baht) from Provincial Energy Office- Nakhon Pathom, Ministry of Energy that could save energy costs, use alternative solar energy, and acquire agricultural knowledge from government agencies in order to apply for standard certification for increased value of the goods.



Figure 4.18 Khun Chaisri Loonlertpol, Pictured in Front of the Rice Mill with Budget Support of 478,000 baht from Provincial Energy Office – Nakhon Pathom, Ministry of Energy

4.4.6.3 Management

Khun Chaisri is highly capable of managing factors of production, labor, and capital, producing, processing rice, and expanding the market through his own marketing channels. He can connect production in accordance with the sales of output in line with the demands of the market and consumers. He undertakes Zero Waste Management such as rice bran from milling that can be used as animal feed and sales.

Khun Chaisri is knowledgeable in the cultivation of riceberry rice and is a good lecturer to transfer technology or give advice to farmers and interested people. He considers land first. What kind of crop was formerly grown on the land or if the soil is newly cleared. The riceberry rice uses the rice seed for only 10 kg a rai due to its light weight. The appropriate timing cultivation is to start on 1 July and 20 November in order to acquire output with good quality.

Khun Chaisri is aware of the product and the safety of consumers. The agriculture certified with the G.A.P. standard as understood by Khun Chaisri is that chemicals can be used but within suitable duration and there must be recording. The remaining days of the harvest must be monitored in ensure that there is no residual chemicals that may impact consumers.

Khun Chaisri is able to easily gain access to knowledge of government agencies and various institutions and receive information, news, IT, and other communications via Smart Phone. He records information on production, prepares income-expenditure account for analysis and planning prior to production in response to the need of the market and uses the information to solve problems and develop his own profession.



Figure 4.19 Interior of Rice Mill with Budget Support from Provincial Energy Office-Nakhon Pathom, Ministry of Energy

4.4.6.4 Enhancement on Own Success and Expansion of Knowledge towards Farmer Network

Apart from the successful cultivation of riceberry rice, Khun Chaisri practices additional integrated farming on the area of 3 rai by cultivating Gimju guava and aromatic coconut. The Mixed/Diversified/Polyculture Farming System is the agricultural system with many production activities to respond to the demand of consumers or reduce price risks of uncertain output without planning, control, and determination since the beginning. The production activities are managed to combine and complement each other to reduce production costs and realize the importance of the environment. Similarly to integrated farming, the mixed farming system may be mutual assistance from production activities. The mechanism is “automatic” not from “knowledge and understanding.” However, the mixed farming can develop farmers’ knowledge and understanding to operate integrated farming by taking output to the

market to sell. Nakhon Pathom Provincial Office provides the space for farmers in Silpakorn University every Wednesday and Friday. For every Saturday and Sunday, they will sell them at the Ban Sala Din floating market. The rest of the week namely every Monday, Tuesday, and Thursday, Khun Chaisri and his wife will spend their time in the farm taking care of the output and preparing the goods for regular customers. Khun Chaisri provides them with the Pre Order via Line and delivers the goods according to the customers' orders the following week.

4.4.6.5 Determination in Agricultural Profession

Khun Chaisri wants to return those who have morally supported him, including family, relatives, sincere customers, friends, supporting community, public and private agencies through adherence to the working and farming profession principles namely "Produce quality goods, taking in account customers, and honesty towards consumers" by applying the Good Agricultural Practices (G.A.P.) as a guideline to practice farming in order to obtain output with good quality and safety according to the standard. The production process must be safe for farmers and consumers alike, without chemical contamination or pollution to the environment, use of resources for maximum benefit, high yield, worth the investment. The production certified with the G.A.P. standard will lead to agricultural, environmental, economic, and social sustainability. The G.A.P. for the cultivation of riceberry rice specifies the necessary management of production process, taking into account the environment, health, safety, and welfare of the farmers to achieve the output with quality, safety, free from pests, suitable for consumption, and with quality that satisfies consumers.



Figure 4.20 Khun Chaisri Feels Happy and Proud of Her Career as a Farmer Because of the Shady Atmosphere of the Riceberry Fields

4.4.6.6 Conclusion

Khun Chaisri's success in Smart Farming comes from the dedication in study and research in riceberry until he can produce riceberry rice and achieve the yield with high quality and in demand of the market. He is also lecturer to transfer knowledge or give advice to farmers and interested people. Another major factor is that Khun Chaisri sells the output directly to consumers by himself without middleman. Apart from satisfactory selling prices, he also receives information directly from customers on the satisfaction of the quality of the bought goods, as well as demand of buying goods in the future, including the quantity and the number of goods, in order to produce in response to the needs of the customers. This kind of information is extremely useful for agricultural profession.

4.4.7 “Pomelo Orchard” 9/1 Moo 4, Bang Toei Subdistrict, Sampran

District, Nakhon Pathom

Khun Uttapol becomes the third generation farmer following his ancestors. His family has tilled the same land of 16 rai for over 100 years. He started life like the son of any other farmers in the area. His parents sent him to school. He graduated with a B.A. degree and worked in his academic line. He lived in Bangkok to look for experience for 5-6 years. When he was saturated, he moved back to his hometown in 2011 which was the year of the great flood in Thailand, especially in Bangkok Metropolitan Region.

The problem of the agricultural sector faced by Khun Uttapol as the third generation farmer following his father and his grandfather was to raise the question to himself whether he wanted to continue the farming profession like his ancestors before him or quit the profession. When he started again after the flood, all the fruits in the orchard died. It was like starting anew all together. The concept of Smart Farming for survival. “It is used as a guideline to reduce costs, self-development, application of the knowledge of Smart Farming in the pomelo orchard. For example, collection of information on the weather, preparation of income-expenditure account to plan production in line with market and consumers.”

The output in Khun Uttapol’s farm is also affected by the epidemic because he relied on export. The farmer’s initial investment was 45% but at present is 50%. The other part is local merchants who come to take them for sale. Once the prices are reached, the merchants will come to harvest the output themselves. Except for pomelo, the owner must collect them himself. The pomelo varieties include Siam Red Ruby, and White Honey. As for betel nuts, the local workers come to harvest them.

Prior to practicing farmer profession, Khun Uttapol used to work as an engineer. After the flood crisis, he decided to return and follow the farmer profession from his parents. He started by improving the area because in the old area, there had been no farming for a long time. He started by bringing in a bulldozer for soil conditioning in parallel with plant cultivation. Farmyard manure and soil-enriching organic fertilizer were used. The concept of organic farming is not to use chemicals

to maintain the soil condition and preserve the environment, as well as for his own health and that of the consumers.



Figure 4.21 Cultivation of Additional Betel Nuts with Pomelos Along the Ditch to Maintain the Conditions of the Bank

Khun Uttapol's orchard makes optimal use of the area. He practices integrated farming as in Figure 4.14. It means the cultivation of various fruits and vegetables such as pomelo, banana, coral tree, wild betel leafbush, betel nut. As pomelo is the fruit that takes a long time before harvest, so it is necessary to grow other plants to generate income while waiting for the harvest. He uses microbial pesticide, makes his own fertilizer to reduce production costs. For farmers, the Integrated Farming System is the system for cultivation of different types of plants in the same area under mutual assistance and benefit for the highest efficiency. The success of integrated farming system depends on the laying out of format and operation by focusing on the efficient activities of each type of plant appropriate to the environment, as well as physical, economic, and social aspects, labor force, investment, land, factors of production, and natural resources. The reason that Khun Uttapol adopted the integrated farming system was because the mainstream farming

especially monoculture or production of one type of agricultural product such as cultivation of only pomelo entailed many problems such as insecure income from the farm output, cultivation of only pomelo requires high investment, and cultivation of numerous plants reduces the risk of output, the dependence on capital, and the fluctuation of market prices. The fact that Khun Uttapol grows banana, coral tree, wild betel leafbush, betel nut will increase the farm output without affecting the output of pomelo at all and enhance output and income.

4.4.7.1 Success Factors of Smart Farming

Khun Uttapol is the third generation of farmer family since his birth. He is very determined to practice agricultural profession. He can efficiently use the IT devices to seek agricultural knowledge. He has knowledge, understanding, and ability to plan marketing. He is also ready to learn and acquire additional knowledge on farming profession from government agencies who regularly organize seminars. He always receives good support from the government. He clearly and systematically records statistics and information and prepares income-expenditure account in farming. He is lecturer to transfer knowledge on organic farming starting from the experiment in his own pomelo orchard. Once successful, groups of farmers were formed by those who were interested in the organic farming principle for widespread application.

4.4.7.2 Application of Innovation or Production Technology

Khun Uttapol stresses the importance of elimination of pests by using microbial pesticides such as mold, bacteria, and virus. It is another alternative that can reduce or replace the use of agricultural chemicals in an efficient and environmental-friendly manner. At present, various technologies are applied especially the bio technology to be used in the efficient product development appropriate to be used in the pomelo orchard. Moreover, the government assumes the driving and supporting role in the use of microbial pesticide to get rid of pests as the guideline to develop the country's safe and sustainable agriculture.

Khun Uttapol focuses on farming with natural methods. His pomelo orchard is free of toxic substances or chemical residues. He avoids chemical contamination, whether in the soil, in the water, and in the air for the bio richness in the eco-system and environmental rehabilitation in accordance with the highest

natural balance without using synthetic chemicals or genetically modified substances and. He also focuses on the use of factors of production with systematic production management plan under the production standard of organic farming for maximum output. It is rich in nutritional value and free of toxic substances. It also helps reduce production costs and can apply the raw materials from nature for better quality of life and support the Sufficiency Economy.



Figure 4.22 Khun Attapol Experiences Happiness and Satisfaction with Non-Chemical Farming Practices, and He Also Finds Fulfillment in Organic Farming Practices

4.4.7.3 Management

Khun Uttapol can act as lecturer to transfer technology or give advice to farmers or those interested in the pomelo cultivation from the beginning of soil preparation, maintenance, use of fertilizer, and elimination of insects without using chemicals. He used to be a community leader as member of subdistrict administration organization and can work with other members who are farmers. He is

ready to work and coordinate with government agencies, including Subdistrict Agricultural Extension Office and District Agricultural Extension Office. He is also ready to cooperate with the central government and has more agricultural information than others.

Khun Uttapol is very knowledgeable in organic farming. His concept of organic farming is not to use chemicals to maintain the soil conditions and the environment, as well as the health of his own and consumers with the production process that is in accordance with the organic farming standard.



Figure 4.23 The Combination of Shade, Humidity and Natural Canals Play an Important Role in Maintaining the Abundance and Abundance of Pomelos During the Dry Season

4.4.7.4 Enhancement on Own Success

Khun Uttapol cooperates with both the public and the private sectors to act as lecturer on various topics such as care of fruit trees after the water recedes, production and use of *Trichoderma* spp. It is the orchard that initiates organic farming while adjacent orchards still practice chemical farming in order to serve as a model orchard.

Apart from pomelo which is a major fruit tree that generates income for Khun Uttapol, he also starts betel nut farming. He grows in addition with pomelos with the distance of 2 meters between the trees. The benefit of the betel palm is that it prevents the erosion of bank in the ditch. If the betel nut trees are not grown close to one another, the ditch will be smaller. But if the roots of the betel nut trees cling to the soil, the bank will not erode. The benefits of the betel palm are not only to use the roots to cling to the bank, the big, tall betel nut tree also provides shade to other plants in the orchard such as lemons or pomelos. The betel nut farming should not be practiced as the monoculture but rather integrated cultivation between betel nut and other types of plants as they will generate income all year round. At present, betel nut is a major export product. A large volume of fresh betel nut is exported to Taiwan, Hong Kong, Vietnam, Myanmar, Japan, US, and African countries. As for dried betel nut, the markets are situated in India, Pakistan, Bangladesh, Saudi Arabia, UK, Australia, New Zealand.

4.4.7.5 Determination in Agricultural Profession of Khun Uttapol Polachai

The main concept and the determination of Khun Uttapol Polachai's agricultural profession are as follows: "I am determined to practice farming profession through strict adherence of the Sufficiency Economy without using chemicals and focus on organic farming for the safety of himself, his family, and consumers." The current agriculture can modify into organic farming by starting to study and seek knowledge from the standard of organic farming. Farmers should start by taking interest in the study of nature. Then, they will move to organic farming at the phase of adaption and learning. Once they implement it with strictness and continuity according to the standard of organic farming, soon it will become organic farming. However, it depends on the type of organic farming with the output

determined in the standard of organic farming. The main principle is to understand organic farming and the determination, diligence, and perseverance in the face of problems or obstacles. Then, the farmers will reach the objectives and succeed without too much difficulty. This is because organic farming is what one can really implement. The farmers can also apply for the standard certification from government agencies before being considered completely organic farming. The farmers themselves, their families, and consumers will be safe and healthy as food from organic farming has high safety standard.

4.4.7.6 Conclusion

Khun Uttapol's pomelo orchard concretely started after the big flood of 2011. With experience accumulated from his ancestors or his parents who were farmers down to Khun Uttapol who is the third generation, he has in-depth knowledge on agriculture. At the same time, he is graduated with a B.A. degree so he has knowledge and understanding of Smart Farming. With adherence to the principle, the pomelo farming can succeed easily in terms of production and marketing. Smart Farming, in Khun Uttapol's opinion and working practice, is to shift farmers' thinking to be able to work in line with the present demand of two generations of people, both old and new, in terms of raw material, cost, and labor management.

4.4.8 “Integrated Agricultural Garden” 21 Moo 2, Tham Rong Subdistrict, Ban Lat District, Phetchaburi 76100

Khun Suriya Choowong's father was originally from Ban Lat and mother from Tha Yang and moved from Tha Yang to reside on the current land of 16 rai. He started farmer profession since he was 12 years old, mostly monoculture. When he was 26 years old, he had the opportunity to have audience with His Majesty the Late King Bhumibol Adulyadej the Great who talked about the Sufficiency Economy as follows: 1) Moderation 2) Reasonableness 3) Self-immunity. Khun Suriya uses the Sufficiency Economy Philosophy as a guideline to practice farmer profession. He started by growing many fruit trees such as palmyra palm, green rose apple, Cavendish banana, aromatic coconut, durian, papaya, sapodilla. He grew them in an integrated and rotating method. The output will yield on a continuous basis and alternately all year round. As for Cavendish banana, Khun Suriya has experience in

cultivation by planning in advance the output to come out at the same time as the high demand of the market. The farmers' costs to grow Cavendish banana in 1 rai or 400 trees require the investment capital of approximately 16,000 baht, profit of approximately 30,000 baht, and cultivation time of approximately 7-8 months. He starts the cultivation approximately between May-June to have output for sales during the Chinese New Year to get good prices. Khun Suriya made sacrifice by not growing Cavendish banana so as not to compete with other members of the farmer groups and turned to grow other types of bananas instead such as dainty banana, lady finger banana.

4.4.8.1 Success Factors of Smart Farming

With existing knowledge and recognition by the community as someone who is able to teach farmers to use materials that are locally available for sustainable self-reliance, as well as create network to expand work such as soil doctor network, accounting teacher network, local philosopher network, etc.

Ability to manage factors of production and labor force in line with the demand of the market, resulting in the agricultural output that comes out in response to the market and with good prices. For example, the cultivation of Cavendish banana requires the duration of approximately 7-8 months by starting the cultivation between May-June to ensure that the output will come out for sales during the Chinese New Year. It is a good marketing planning. He also seeks the ways to reduce production costs as a precaution in profession and systematically plan family expenses.

Awareness of the quality of goods and output. It is the result of learning from real practice in the area of 16 rai for integrated farming as in Figure 4.15. The area includes paddy cultivation and vegetables free from toxic substances such as rose apple, sapodilla, lemon, papaya, Marian plum, Gros Michel banana, dainty banana, Ducasse banana, palmyra palm, etc. which are certified with the G.A.P. standard for plants; production of bio fertilizer, bioextract; output certified with agricultural goods and food standard or the Q logo; confidence for consumers on food safety and quality; production process that is compliant with the G.A. P. standard; and organic farming is the product that is safe for consumers.

Time management. Work for the common good and community. Role model for way of life. Recognition by people in community. Lecturer to transfer work and knowledge to interested people to acquire knowledge, techniques, and methods of farming, in-depth knowledge on plants, accounting, and giving advice to farmers, and the general public who are interested or have problems from farmer profession. Role model for farmers in the area and outside.

Khun Suriya is determined to practice farming profession. He loves and cherishes the area and the farming profession for his daughter who is the heir of the next generation to be happy and satisfied with farming profession.



Figure 4.24 Plot of “Integrated Agricultural Garden” with the Cultivation of Lemons with Other Plants

4.4.8.2 Application of Innovation or Production Technology

Khun Suriya produces his own bio fertilizer to be used in his integrated orchard. It is yet an evolution to make use of fertilizer as this type of fertilizer has a component of living microbe. It is not the supplement of nutrient

directly in the soil but it makes use of the ability of the microorganism to create nutrient for the plants in the long term or change some components already existed into something that plants can benefit. It means that the microorganism that is used to produce bio fertilizer must have the special quality in response to the need. At least, 3 main nutrients must be added namely nitrogen, phosphorus, and potassium. Bio fertilizer is also called microbial fertilizer which enriches the soil physically, biologically, and biochemically.

Khun Suriya produces bioextract by fermenting plants, vegetables, fruits, and various animals with sugar, resulting in a large number of useful microorganisms which will help digest nutrients in the plants. It has the value in terms of plant nutrients when digested. The digested process of bacteria or microorganisms will be released such as protein, amino acid, major nutrients, minor nutrients, micro nutrients, growth hormones, and vitamins which plants can efficiently use for growth.



Figure 4.25 Khun Suriya has Applied the Principles of Sufficiency Economy to his Smart Farming Practices and Has Focused on Tracking Income and Expenses

4.4.8.3 Management

1) Khun Suriya has followed the Sufficiency Economy Philosophy for the past 35 years. He stresses sufficiency, moderation, and self-reliance.

2) He uses reason in living and profession.

3) He records household account, farm account, and record of the agricultural information to analyze production planning.

4) He has creativity, sacrifice, and serves as volunteer to transfer knowledge and experience on agriculture to interested people.

5) Learn from real practice in the area of 1 6 rai with integrated farming of paddy farming and cultivation of non-toxic fruits such as rose apple, rose apple, sapodilla, lemon, papaya, Marian plum, Gros Michel banana, dainty banana, Ducasse banana, palmyra palm, etc., which are certified with the G.A.P. standard for plants

6) Produce bio fertilizer, bioextract, and insect trap used in the field to reduce production costs. The output is certified with the agricultural product and food standard or the Q logo to ensure consumers' confidence in terms of food safety and quality

7) Plan production, marketing, and search for ways to reduce production costs, take precaution in the profession, and systematically plan the family expense

8) Time management. Work for the common good and the community. Role model in living life. Recognition by people in the community.

4.4.8.4 Enhancement on Own Success

Khun Suriya is recognized to be the leader in preparing the farm account and use the recorded information on agriculture to plan cultivation so that the output meets the market mechanism. He can develop himself towards success, assumes the role of leadership and model of living life according to the Sufficiency Economy philosophy, and the integrated farming according to the new agricultural theory. He has also been on radio program at Radio Thailand Phetchaburi FM 95.75 with the Agricultural Phetchaburi program of Phetchaburi Provincial Agriculture and Cooperatives Office from 1992 until the present. He is also invited to lecture on

palmyra palm and he is advisor on information of palmyra palm to Phetchaburi Rajabhat University, and Kasetsart University, at Bang Khen Campus. He also brings groups of students and farmers from many countries for study tours under the projects of the universities and disseminates knowledge on agricultural wisdom via newspaper, television, and exhibitions.



Figure 4.26 The Iron Stair to Climb the Palm Trees Instead of the Long Bamboo Due to Better Durability and Utilization

There is also no safety risk of the long bamboo as the bamboo can damage or break. The long bamboo is considered the main and important tool for the locals whose profession of climbing up the palm trees in Petchaburi can use it to climb to the top of the palmyra palm tree. It is the tool that is easily available in the local area. The locals with the profession of climbing the tree would use it from the past till the present. Importantly, the long bamboo is difficult to find as it cannot grow fast enough to respond to the users' needs in large quantity. The length of a long bamboo is approximately 6 meters. Each piece of wood is expensive or as high as 200-300 baht a piece. For one palm tree, high investment is required to buy the long bamboo at the price of 1,200 baht and can be used at the most only 2 years

before requiring to invest in buying a new long bamboo to replace the damaged one. The long bamboo that is formerly used has short work life. Soon, one has to buy a new one. Due to the experiment on making an iron stair to climb up the palm tree, it can be used for good benefit. It can be moved conveniently. In the past, the long bamboo had to be flatly tied with the palm tree at all time and would not be moved from tree to tree. As it is made of iron, the new stair is stronger and more resistant than the long bamboo with the working life of only 1-2 years and then will be degraded with time due to exposure to the sun and the wind. Once degraded, it will be necessary to buy a new one. The iron stair can support wood with the weight of 60 kg. as in Figure 4.16. Investment is small at only 1,600 baht. It is a one-time investment but can be used forever without having to reinvest. He has also registered a patent for the concept of the stair to climb up the palm trees that he invented.

4.4.8.5 Determination in Agricultural Profession

Khun Suriya is determined to practice farming as a profession. “I want to be a leader in implementing the Sufficiency Economy Philosophy of His Majesty the Late King Bhumibol Adulyadej. Up till now, he has adhered to the principle for over 35 years with focus on sufficiency, moderateness, and self-reliance, reasonableness in living his life and practice of farming.” Sufficiency Economy is the philosophy that focuses on the guideline of living and behavior of people at all levels from the family, community, to national levels, as well as the development and the national administration to move along the middle path especially the economic development to keep abreast with globalization. Sufficiency means moderateness, reasonableness, as well as necessity to have good self-immunity from any impacts derived from external and internal changes. It requires knowledge, prudence, and extreme caution in using academic works to plan and operate in all processes. At the same time, the spiritual foundation must be promoted for people in the nation especially government officials, theorists, and businessmen at all levels to have awareness of morality, honesty, integrity, and appropriate mastership, living lives with perseverance, diligence, presence of mind, and caution to ensure balance and readiness for rapid and widespread changes in terms of materials, society, environment, and culture from the outside world.

4.4.8.6 Conclusion

His experience in farming is in line with the concept of Smart Farming that is used in farming until meeting with his present success. It requires recording, advanced production planning, as well as sales of quality output. Khun Suriya acts as a lecturer who transfers his work and knowledge to those interested on the techniques and methods of farming, in-depth knowledge on various plants, accounting, and as an advisor who gives advice to farmers and the interested general public or those with problems of farming profession. He is also a model for farmers both in and outside the areas and invents agricultural innovation such as iron stair to climb up the palm tree, the tool to wash the sapodilla, local water management system, black light to collect insects, yellow trap to catch the oriental fruit fly, etc. He teaches farmers to use local materials for sustainable self-reliance, as well as builds network to expand work such as soil doctor network, accounting teacher network, local philosopher network, etc. He is also member of network expansion such as member of study of accounting, club for volunteer accounting teachers at the national level, member of Agricultural Productivity Efficiency Increasing Learning Center at Tham Rong Subdistrict. He is a smart farmer who is highly applaudable.

4.4.9 “Pin-Chai Date Orchard” Residence at 13/1, Moo 3, Nang Kaeo Subdistrict, Photharam District, Ratchaburi

After graduating with B.A. degrees from Ratchaburi, Khun Chatchai and Khun Tepin went to work in a company in Bangkok for nearly 8 years using the knowledge acquired but expense exceeded income. Their parents were originally farmers with their own land, and their childhood friends since the primary school are also local farmers with paddy fields and vegetable orchards. Some attended the Young Smart Farmer project and used the acquired knowledge as the guideline for Smart Farming. After experimentation according to the guideline, they saw the success of farmer profession and invited Khun Chatchai and Khun Tepin, husband and wife, to return to their hometown to practice farming at Nang Kaeo Subdistrict, Photharam District, Ratchaburi.

Later in 2002, Khun Chatchai moved back to his hometown to practice agriculture just like his ancestors. But he did not like to grow paddy like his parents due to frequent problems in terms of low prices. So, he started by growing sweet bamboo and selling the shoots, rotating crops, annual crops, eggplant, cow-pea, gourd, bitter gourd, bottle gourd on the land of 5 rai. The middleman would come to take them for sale instead of growing paddy like other local farmers. At the same time, after receiving the information from his village friends who had already participated in the Young Smart Farmer training, he was interested in applying the knowledge as the principle in farmer profession.

In 2015, Khun Chatchai went for a study tour of date cultivation in Kanchanaburi. The BAHE strain is the best strain of Iraq. The tissue will be spun and cultured in a nursery in England for about 1-2 years. Usually, 25 trees are planted for the area of 1 rai. Khun Chatchai studied the details of the strain, insects, and pests until he had clear understanding before he decided to plan to start the investment.

In 2017, upon the detailed study of the qualifications of dates both strong and weak points, Khun Chatchai and Khun Tepin decided to invest in date cultivation. They bought date trees for 1,600 baht per tree for 100 trees with the total investment of 160,000 baht. Presently, there are in total 114 trees on the land of 5 rai. The reasons that motivated Khun Chatchai to decide to grow dates were as follows:

- 1) He likes and is enchanted with the charm and the taste of dates which are unique and different in taste from other fruit trees, as well as numerous good qualities in terms of food and energy.
- 2) The cultivation requires only once. The date is a perennial plant that can reach the age of 100 years old. It is different from rice cultivation or other annual crops which when after the harvest, new investment is required.
- 3) The tree is resistant to the climate of Thailand. In the dry season, it is resistant to the dry weather even in a desert. In the rainy season, it can resist wind current or storms.
- 4) During the dry season, it gives shade with greenness and agreeableness. It is the source which produces and returns pure oxygen to nature and the environment.

5) In terms of income, when the tree is 5 years of age, it will yield the output of 100 kg/tree. Figure 4.17. The current buying price at the orchard gate is approximately 200 baht/kg and the income is approximately 20,000 baht/tree/year.

Date is a new economic crop that many farmers presently turn to cultivate. It is a fruit for export due to high demand overseas. Even domestically, there is high date consumption which increases the price of dates. The strong point of date cultivation is that only one-time investment is required. Afterwards, one only has to harvest the output. One does not have to invest in the cultivation again as other annual crops. The investment is required at first. The rest is to maintain and study the methods to increase the output.

4.4.9.1 Success Factors of Smart Farming

Khun Chatchai and Khun Tepin are the children of farmer families since their birth. Therefore, they are highly skillful in farmer profession. They are determined to reach the target of practicing farmer profession. They are able to use the IT devices to search for information, additional knowledge on farming profession. They can plan marketing and conduct online marketing via Facebook, advertisement, and public relations to sell the dates from the orchard. They are interested in seeking additional knowledge by regularly attending trainings and seminars organized by government agencies. They regularly record information and statistics and prepare income-expenditure account. They are able to process output such as packing of date juice in plastic cup for sale and have a project to develop the date orchard into agro-tourism in the future.



Figure 4.27 Date Trees Aged 5 Years Old That Started to Yield Output and Ready for Sales

4.4.9.2 Application of Innovation or Production Technology

The cultivation of dates is based on tissue culture. Date is a dioecious plant. The farmers who grow and want output must grow only female plant. Therefore, for seed propagation, apart from the risk of plant mutation, there is also high risk of having more male than female tree. Importantly, one will know after cultivation for 2-3 years. Therefore, the farmers prefer buying the date seedling from tissue culture from abroad with the high price of 1,500-2,000 baht per tree. The good point of tissue culture is that the acquired seedling has exactly the same quality as the female seedling. There is no plant mutation. The output from the seedling from tissue culture has high quality and regularity. The propagation yields a large amount of output fast and appropriate to commercialized cultivation. The weak point of tissue culture is that it requires higher investment than seed cultivation. As the propagation with this method is not widespread in Thailand, it must be imported. Presently, there is date tissue culture in Thailand to acquire female seedling by using side shoots or inflorescences for incubation in sterile condition or feeding with artificial food to generate callus. Then, they will become small saplings, roots, and will be fed until they become saplings with rich leaves and roots. After approximately 2 years, they will be transferred from bottle or test tube and grown in

plant nursery for another 12 months before being transferred into a cultivating plot. But if a lot of seedlings are required, it needs more time according to the required number of the seedlings. But they should not be bred in sterile condition for a long period of time or the callus should not be increased in quantity in many rounds because it will cause genetic variation due to cloning.



Figure 4.28 Dates with the Orchard Gate Price at 200 Baht a Kg.

4.4.9.3 Management

In 2018, Khun Tepin participated in the Smart Farmer project with Photharam Agricultural Office, Ratchaburi and used the knowledge to improve and develop agricultural practice with Khun Chatchai for integrated farming which yielded more output due to work planning, recording, and income-expenditure accounting.

Khun Chatchai and Khun Tepin are able to gain easy access to information and knowledge of government agencies and various institutes, as well as other information, news, IT, and communication channels through Smart Phone. They record information on production, prepare income-expenditure account to analyze the planning prior to operation in line with the demand of the market and use the information to solve problems and develop their own profession.

Planning of the sales of output from Pin-Chai Date Orchard in advance before the season of harvest as the following details:

1) Sales in front of the orchard and arrange for the location to provide information and a learning center for farmers and the general public who like and are interested in dates as in Figure 4.18.

2) Online delivery by which customers are interested in the information via social media including page, Facebook, website, as well as direct sale.

3) Distribution to the wholesale shops at Talaad Thai, a huge wholesale center, which provides services to retail shops who will come for the products and resell them at markets, communities, and further to consumers in households.

4) WDP Co., Ltd. is a date processing company of energy drink and fresh date juice and exports to Lao PDR and Cambodia. Domestically, it is on sale in general convenience stores such as Top Supermarket, Max Value, Central Department Store, the Mall.



Figure 4.29 In front of Date Orchard to be Developed into Agro-Tourist Destination

4.4.9.4 Enhancement on Own Success

Presently, the farmers in the local community group themselves to grow dates on the land of over 20 rai and start to have output into the market. It is the investment that greatly generates income to the local farmers and makes the economy of the participating households better. Dates yield output faster than avocados. The date tree will yield the first output in approximately 5 years. At the beginning, advice was given to members to practice integrated farming by growing dates which is a perennial fruit tree that has a long life of 100 years. Also in the same area, there should be cultivation of annual crops, rotating crops, or animal breeding in parallel to ensure income from many sources.

4.4.9.5 Determination in Agricultural Profession

“In the future it is our wish to turn the Pin-Chai Date Orchard into agro-tourism destination”

Khun Chatchai and Khun Tepin envisage the benefits that will derive from agro-tourism as in Figure 4.19. Apart from generating income from tourism for farmers, the agro-tourism will offer other numerous benefits. For example, the good knowledge on preservation and management of tourist resources will generate cost effective business profits, reduce the unnecessary consumption of resources, and reduce waste from consumption. Farmers will cooperate to preserve and promote natural, social, and cultural diversities. Moreover, there is coordination to develop tourism with the activities and strategic plans for development at the national and local levels. Local economy is promoted by using local raw materials and providing the opportunity for local participation in tourism development, distributing income to communities, and focusing on sustainable agro-tourism.

4.4.9.6 Conclusion

Khun Chatchai and Khun Tepin are the children of farmer families since birth. So, they are highly skilled in farmer profession. They are diligent and determined. They are also capable of using IT devices to seek information and additional knowledge, planning marketing, and practicing online marketing, advertisement and public relations. They take interest in seeking additional knowledge by regularly attending trainings and seminars organized by government agencies. They record information and statistics, and regularly prepare income-

expenditure account. They can process the output. They plan to develop the date orchard into an agro-tourism destination in the future. The choice for Khun Chatchai and Khun Tepin to grow dates is the more interesting as in the future there will be a project to develop the date orchard into an agro-tourism destination which is an extremely interesting issue for farmers and those interested in farmer profession with new economic plants.

4.4.10 “Bangkachao Farm” Soi Phetcha Hueng 21, Bang Yo Subdistrict, Phra Pradaeng District, Samut Prakan

From the problems of land for subsistence of farmers who faced the crisis of the great flood in 1985, the rose apple orchard of Khun Thaweesak’s mother suffered severe loss. Over 1,000 rose apple trees all died. They turned to grow aromatic coconut as they could not grow rose apple due to polluted water in all the canals in Bangkok that were connected with the Chao Phraya River. In the dry season with the surge of sea water, at that time, there was no watergate. Water would deteriorate and almost all plants would die so that the orchard was entirely damaged. Until 1991, under the administration of Prime Minister Anand Panyarachun who formulated the policy to appropriate land in Bangkachao District as Bangkok’s lungs and transfer residents to Paet Riew, Chachoengsao. But some residents protested. So, the government changed the policy to buy the land at the willingness of the residents. Khun Thaweesak’s mother did not sell the land but wanted to keep the land for her children and grandchildren to practice farming to feed themselves by changing to the cultivation of aromatic coconut but the output was not abundant due to the problem of the soil condition. Until the present, Khun Thaweesak changed the crisis into the opportunity by changing the traditional farming to Smart Farming with his diligence and dedication until he met with satisfactory results. Moreover, he inspired interested farmers to come and study the guideline for their enhancement. They all expect to succeed in their farmer profession in the future just like Khun Thaweesak.

“Bangkachao Farm” is situated on the area of approximately 12 rai in the area of Kung Bangkachao. It is part of a large green area near Bangkok. It is one the major oxygen-producing sources in Thailand. Moreover, it is the community valued

for its environmental, economic, touristic, social, and cultural aspects. However, at present, the community faces a serious problem of urban expansion and climate change.

In 2017, Khun Thaweesak started growing vegetables with the Aquaponics method. It is cultivation in the water. Below Khun Thaweesak bred snakeskin gourami whereas the vegetables were above. For the first round, the output was very good. But for the second round, everything was damaged. Because when the fish started to become bigger, the excretion was greater. The water became polluted. There were a lot of bacteria clinging to the roots, knotting and rotting the roots. The vegetables all died. Khun Thaweesak had to find other sources of knowledge to continue with his farmer profession.

In 2018, Khun Thaweesak had the opportunity to study worm breeding with Acharn Somchai Chansawang who gave free lecture at Kasetsart University as in Figure 4.20. After the study, Khun Thaweesak started to undertake worm breeding at home. The main objective was to use it as fertilizer to reduce costs for the cultivation of vegetables. The main cost for worm breeding was the purchase of coconut dust which is minced coconut scraps approximately 80-100 baht a sack as main raw material for the breeding. Until he met an older friend who had a termite mushroom farm for export to Japan. He started to take interest and started a mushroom house that could keep humidity. At the first experiment, from 10 mushroom pieces, they presently increased to 20,000 mushroom pieces, at 25 baht a piece. The damaged or the expired piece would be used to feed the worm instead of coconut dust with the kind assistance from the friend's farm. When the mushroom pieces would be disposed, he would ask his workers to go and fetch them and use them instead of minced coconut for worm breeding. The other main cost was cow dung. The worm was formerly bred in plastic bucket. He restarted the experiment by improving the breeding on the plot with vegetables above and worm below. The water used to water the vegetables above would flow down the worm that was bred beneath so it automatically received humidity without wasting time to water the worm any longer. The water, time, and energy were effectively saved.



Figure 4.30 Breeding of Worms on the Plot by Growing Vegetables Above and Worms Below. The Water Used to Water the Vegetables will Flow Down to the Worms

In 2019, Khun Thaweesak was supported by Department of Livestock Development to experiment the breeding of ducks and chicken until he was highly successful as in Figure 4.21. They are fed by vegetable scraps from the trimming of the farm output for attractiveness before being sold. Instead of throwing away these vegetable scraps as waste, they were used as food for ducks, and chicken and received in return duck and chicken eggs. The duck and chicken droppings would be composted as fertilizer.

During that time, the farm management system was put in place. Next, Khun Thaweesak focused on environmental-friendly alternative energy as clean energy. He turned to solar energy by installing solar cells in the farm and managed to reduce 2,000 baht a month of electricity costs. He could also reduce 3,000 baht a month of electricity costs at his residence.



Figure 4.31 Duck Breeding Supported by Department of Livestock Development, Ministry of Agriculture and Cooperatives

4.4.10.1 Success Factors of Smart Farming

Khun Thaweesak receives the skill for the practice of farmer profession from his mother who has practiced fruit farming to feed the family all her life. So, Khun Thaweesak has good knowledge and understanding of the context of farmer profession. Khun Thaweesak is the man with strong commitment and intention to succeed in the farmer profession. He has the ability to use the IT media in search for knowledge on his profession. He can plan marketing and online market, as well as advertisement and public relations to the group of customers interested in Bangkachao Farm's goods and services through Facebook. He is eager to seek additional knowledge from trainings and seminars regularly organized by government agencies. He can use the IoT devices in mushroom cultivation in the farm for operation standard, convenience, and saving of time, costs, and labor costs.

The farm's output is certified with the standard of Good Agriculture Practices (G.A.P.). Department of Agriculture, Ministry of Agriculture and Cooperatives, is an agency responsible for certification of quality management, good

agriculture practices for plants, by determining the requirements, regulations, and assessment methods in compliance with international principles to serve as the standard for the production of crops at the farm level in the country, as well as preparation of a handbook on crop cultivation according to the principles of G.A.P. Moreover, Khun Thaweesak prepares recording of information and statistics, income-expenditure accounting, for efficient planning of the farm operation. In the future, Khun Thaweesak plans to run a project to develop Bangkachao Farm into agro-tourism for interested customers to come and visit the farm with the pure natural atmosphere as the selling point near Bangkok.

4.4.10.2 Application of Innovation or Production Technology

Khun Thaweesak can undertake management of the cost-effective use of materials and devices without using chemicals. He manages to reduce waste to become part of the production chain. He reduces energy consumption for clean environment, stresses the importance of household waste which is food scrap waste in household by modifying the miniature waste disposing machine for compost processing within 24 hours as in Figure 4.22. He works with the microbes invented by himself. They were made in 3 sizes namely 50 liters for 18,000 baht, 100 liters for 22,000 baht, and 200 liters for 25,000 both, pending patent registration. He submitted the product for quality testing of the compost at Land Development Department and found that the value was higher than the specified standard with pollution-free, and environmental- friendly production process (Green Economy).



Figure 4.32 Miniature Waste Disposal Equipment Modified by Khun Thaweesak to Process into Compost within 24 Hours by Mixing with Microbes

4.4.10.3 Management

Khun Thaweesak is highly capable of managing factors of production, labor, and capital. He is capable of linking production and market to be able to sell his products. The market where the products from his farm are on sale is at Bangnamphung Floating Market, Healthcare center, Bamrungrad Hospital in cooperation with M.K. Real Estate Development Public Company Limited. As for the produces, apart from salad, there are mushrooms, duck and chicken eggs.

Khun Thaweesak's Bangkachao Farm is the only farm in the province which is certified with the standard of Organics Thailand. At present, it cooperates with the Sampran model to act as a coach to set up organic farming groups by grouping local farmers to start organic farming with 3 batches, and 30 farmers called "Khung Bangkachao Organic Farming." The members have good understanding of Smart Farming and use the IOT in their work. Watering is controlled by the Smart Phone.

Khun Thaweesak organizes CSR activities on a continuous basis such as activities organized for schoolchildren, university students, various institutes to come and learn about the organic farm based on Zero Waste, management of food scraps into fertilizer within 24 hours, making of Eco-print cloth bags, and demonstration of making salted eggs with the *Ardisia polyccephala* plant.

Khun Thaweesak is capable of efficiently using online media to advertise or publicize “Bangkachao Farm” to customers and those interested in the farm’s activities and products through Facebook Fan page called “Bangkachao Farm”. Customers can order products, reserve food and various activities organized by the farm with convenience and speed through the page “Bangkachao Farm” every day.

4.4.10.4 Enhancement on Own Success

Khun Thaweesak’s Bangkachao Farm is the only farm in the province certified with the Organics Thailand. Presently, he cooperates with the Sampran Model as a coach to set up organic farm groups by grouping the local farmers to start organic farming in 3 batches, 30 farmers in each batch called “Khung Bangkachao Organic Farming.” The members have good understanding of Smart Farming. The IoT is used for work. Watering is controlled by the Smart Phone. The groups run a project based on the MOU with PTT on Smart Farming and on fertilizer made from waste. Moreover, other agencies both public and private participate in numerous activities with the farm such as Kasetsart University, National Research Council of Thailand, Central Department Store, M.K. Real Estate Development Public Company Limited, Suan Sampran, the market where the groups’ products are on sale at Bangnamphung Floating Market, Healthcare center, Bumrungrad Hospital in cooperation with M.K. Real Estate Development Public Company Limited. As for the output, apart from salad they are mainly mushrooms, duck and chicken eggs.

4.4.10.5 Determination in Agricultural Profession

In the future, Khun Thaweesak did not want to practice only vegetable cultivation business but also environmental management with focus on ecotourism, local wisdom, trainings and seminars by focusing on additional income. The ecotourism according to Khun Thaweesak’s wish is responsible tourism in tourist destinations with unique local identity and ecocultural sources. There is also common learning process of stakeholders under environmental management and participatory local tourism focusing on raising awareness of sustainable ecosystem such as responsible tourism in natural tourist destinations, tourism in complete system of natural sources, unique identity or culturally based natural tourist destinations, systematic environmental management to maintain sustainability of the ecosystem

and continuous learning process of relevant persons. But local people must participate in the management, arrangement, operation for benefits and maintenance.

4.4.10.6 Conclusion

As Khun Thaweesak is the son of fruit farmers by origin, he has learned about the farmer profession from his mother since childhood and has good experience in farmer profession. He experiences the hardship of farmers who have to face with floods from natural disasters, degraded soil, source of polluted water, and epidemic from pests. Upon resignation from his regular job, he practiced the farmer profession with the wish to avoid past problems faced by the farmers. Smart Farming is therefore a guideline of knowledge in practicing the profession that Khun Thaweesak places importance on and adheres as the core of work based on hard work, diligence to seek additional knowledge, and not giving in to hardship.

Khun Thaweesak has good knowledge and understanding in the context of farmer profession. He is committed to the successful farmer profession. He is knowledgeable and able to use the IT media. He plans marketing and online market, as well as advertisement and public relations. He is enthusiastic in searching for additional knowledge and using the IoT devices.

The farm output is certified with the Good Agriculture Practices (G.A.P.) by Department of Agriculture, Ministry of Agriculture and Cooperatives. Moreover, Khun Thaweesak records information and statistics, and prepares income-expenditure account, to efficiently plan the farm operation. Due to his success, Khun Thaweesak is willing to transfer knowledge from his experience to benefit farmers and those interested in the farmer profession. Khun Thaweesak is considered yet another commendable Smart Farmer. In the future, Khun Thaweesak will run a project to develop Bangkachao Farm as an agro-tourism for interested customers to come and closely experience the success.

4.5 Key Success Factors of Smart Farming

The key success factors of Smart Farming (Ministry of Agriculture and Cooperatives, 2022) consist of the following:

4.5.1 Knowledge of the Current Activity

Analysis based on the following considerations:

- 1) Can serve as lecturers to transfer technology or advise to others
 - (1) Have been invited as lecturers in various forums
 - (2) Have given advice to other farmers
- 2) Can serve as model farmer or point of learning to others

Visitors have already come to study the plots

Center of learning under the projects of Ministry of Agriculture and Cooperatives or other agencies

4.5.2 Information to Support Decision-Making in Production and Marketing Systems

Analytical methods with the following considerations:

- 1) Access to information sources from officials, IT system, and other communication channels such as Internet, Mobile Phone, Smart Phone, etc.
 - (1) Know and regularly contact officials at Ministry of Agriculture and Cooperatives to ask for various kinds of information
 - (2) Use Internet through various devices to search information on agriculture
- 2) Record information and use the information to analyze and plan before starting operation and manage output in line with market demand
 - (1) Record or prepare household account for financial planning
 - (2) Record of information of production, harvest, and sales of household's agricultural goods
- 3) Information is used to solve problems and develop farmers' own profession
 - (1) Appropriate change of period of cultivation, growth, and harvest based on the data analysis
 - (2) Farmers can confirm if the information used to solve the problems and develop their own profession can increase output or income or not

4.5.3 Output and Marketing Management

Analysis based on the following considerations:

- 1) Ability to manage factors of production, labor force, capital, etc.
 - (1) Methods to reduce costs of factors of production such as composting, etc.
 - (2) Mainly use labor force in household and hire external labor force as necessary
- 2) Ability to connect production and marketing to sell output
 - (1) Able to sell all output
 - (2) Clear and advanced orders enable continuous production planning
- 3) Zero waste management
 - (1) Use of agricultural residues to make compost or biofuel
 - (2) Use of agricultural residues to process into goods for sales

4.5.4 Awareness of Product Quality and Consumer Safety

Analysis based on the following considerations:

- 1) Knowledge or training on the standards of G.A.P., G.M.P., organic farming, or other standards
 - (1) Knowledge on standards from officials or search by oneself
 - (2) Trainings on the standards of G.A.P., G.M.P., organic farming, or other standards
- 2) Production process in accordance with the standards of G.A.P., G.M.P., organic farming, or other standards
 - (1) Intention to produce agricultural goods in compliance with the standards of G.A.P., G.M.P., organic farming, or other standards
 - (2) Certified with the standards of G.A.P., G.M.P., organic farming, or other standards

4.5.5 CSR

Analysis based on the following considerations:

1) Production process that does not generate pollution and does not destroy the environment (Green Economy)

- (1) Never burn stubble or agricultural residues
- (2) Use bio fertilizer and reduce the use of chemical fertilizer
- (3) Use bio technology to eliminate pests and reduce chemical pesticides

2) Continuous CSR activities

- (1) Donate cash or kind to individuals, temples, or academic institutions in community
- (2) Cooperate with community for community service at various occasions

4.5.6 Pride of Being Farmers

1) Commitment in practicing farming profession

- (1) Agricultural activities in the plots by themselves and families rather than hiring external labor force
- (2) Improve agricultural production process from additional information or knowledge

2) Love and cherishment of the land and farmer profession for the next generation

- (1) Inheritance of household's agricultural land from the old generation to the next
- (2) Teach household members to love and cherish the land and the farmer profession

3) Happiness and satisfaction of farming profession

- (1) Farmers can confirm if they can solve or manage the problems during production
- (2) Farmers can confirm if the farmer profession results in high income and good quality of life

**4.5.7 “Chokanan Farm” Hydroponics Vegetable Farm, Amphawa
Subdistrict, Amphawa District, Samut Songkhram**

Table 4.5 Owner Mr. Wonganan Sukcharoenkana

No.	Qualifications	Findings
1.	Knowledge of the Current Activity	Lecturer who provides knowledge from real experience starting from the strength and weakness of Nutrient Film Technique (NFT), factors impacting the growth of plants using the NFT, and demonstration of the cultivation of hydroponics salad using the NFT. Moreover, he cooperated with Assoc. Prof. Dr. Thammasak Thongket, Department of Horticulture, Faculty of Agriculture, Kasetsart University, Kamphaeng Saen Campus, who is the expert on vegetables and hydroponics system under the condition of “Protected Cultivation to produce clean vegetables with the standard of controlled condition.”
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Good access to information and knowledge of officials from Ministry of Agriculture and Cooperatives, institutes, and organizations through IT system and other communication channels via Smart Phone. Moreover, he undertook recording, income-expenditure accounting, detailed information of customers, clear statistics of sales and cultivation of salads on a monthly basis. He could use the information to accompany the analysis and planning of the cultivation of each type of vegetable in line with the demand of market and customers. He also used the recorded information to solve problems and develop his own profession.
3.	Output and Marketing Management	Recording, income-expenditure accounting, detailed information of customers, statistics of systematic sales of salads on a monthly

No.	Qualifications	Findings
		basis and use of the information to accompany the analysis and planning of the cultivation of each type of vegetable in line with the demand of market and customers, as well as use of the recorded information to solve problems and develop his own profession. For example, use of monthly orders from customers abroad to plan production and cultivation in each cycle requiring the period of 45 days in accordance with the quantity and quality of the Global G.A.P. standard in response to the demand of customers and efficiently reduce the problems of unsold goods.
4.	Awareness of Product Quality and Consumer Safety	Hydroponics vegetable farm certified with the Global G.A.P. safety standard recognized worldwide. The main principle of retail trade at present is the demand of reliable standard to ensure confidence that the goods come from sustainable and safe farming. The Global G.A.P. standard is recognized at the highest level for sustainable and safe agricultural farm.
5.	CSR	Transfer of knowledge of the current farming profession for the general benefit of the surrounding community in Samut Songkhram, of which Samut Songkhram Provincial Agriculture and Cooperatives Office and Department of Agricultural Extension, Ministry of Agriculture and Cooperatives organized the activity for farmers interested in hydroponics farming to undertake study tours of the farm operation. During COVID-19, he offered salads to Somdetphraphutthaloetla Hospital which is Samut Songkhram General Hospital, Amphawa Hospital, a community hospital in Amphawa District, Napalai Hospital at Bang Khonthi District, donation to Child Protection Foundation and Sawang

No.	Qualifications	Findings
6.	Pride of Being Farmer	Benjatham Foundation to the disabled and the blind. Committed, determined, and proud to be a Thai farmer that can cultivate vegetables that meet the Global G.A.P. standard and successfully export to Europe and will maintain this standard as long as possible and to the best of his ability. Love and cherish the land and the farming profession for the next generation

4.5.8 “Melon & Salad Farm” Allocation of Half of the Land for Digging Pond, Khlong Jed Subdistrict, Khlong Luang District, Pathum Thani

Table 4.6 Owner: Mr. Suriya Choowong

No.	Qualifications	Findings
1.	Knowledge of the Current Activity	Use smart phone system to save costs, labor costs, and time. It is the farm with good water management. Hydro-Informatics Institute (Public Organization) assists in the automatic farm control system with special qualifications. Not only can it control temperature, air, humidity in the air and the soil, automatic spraying of water, fog, drug, and automatic air ventilation, it can also compile information from wireless sensor in parallel with meteorological information from satellite, model of weather, to be processed in order to improve the planning of cultivation in the next cycle where everything can be controlled, information can be sent, and warning can be given through smart phone or tablet.
2.	Information to Accompany Decision-Making on	Recording, income-expenditure accounting, detailed information of

No.	Qualifications	Findings
	Production and Marketing Systems	customers, as well as statistics of monthly sales of salads and melons on a systematic basis by using the personal computer and using the information to accompany the analysis to plan each type of plant in line with the demand of market and customers, as well as using the recorded information to solve problems and develop his own profession. For example, at first, the cultivation was undertaken outdoor. The first cycle yielded abundant output. But in the following cycle, the insects started to cause trouble. Almost all output was damaged. So, he analyzed the recorded information and turned to greenhouse in the closed system and in controlled condition and completely started the new cultivation process because cultivation in a greenhouse is different from outdoor especially for soil formula or fertilizer formula. He continued to study by himself until he acquired his own formulas and was successful in 2015 and the formulas have been used in the farm ever since.
3.	Output and Marketing Management	Ability to manage factors of production, labor force, and capital, etc. At present, the farm can deal more with problems and obstacles from past experience. He takes more precaution and able to connect production and marketing to sell output and improve the farm area as community market that attracts more tourists resulting in increased sales. The farmer group in Khlong Luang District, Pathum Thani is more ready to provide services by placing more output for sales in various locations. Moreover, the output that does not meet the requirement or is unsold will be kept whole in the refrigerator and as food in the farm. Some will be processed into ice

No.	Qualifications	Findings
4.	Awareness of Product Quality and Consumer Safety	cream and sweets without waste. It is Zero Waste Management. At present, 4 vegetables namely melon, tomato, salad, and mulberry request the certification of the G.A.P. standard. Additional study is also conducted to request Organic Thailand for vegetables to ensure consumers' confidence in safety standards
5.	CSR	Production process that does not generate pollution and does not destroy the environment (Green Economy), reduce the use of combustion engine and basically focus on solar energy for farm equipment. Moreover, solar cell provides energy from backup power. Continuous CSR activities at the farm. It is learning center for farmers and interested public to visit the farm which is always wide open for study and exchange of opinions.
6.	Pride of Being Farmer	Committed to farmer profession. He wants the profession to be more secure in order to feed his family. He loves and cherishes the land and farmer profession for the next generation. The farm places importance on agricultural land through optimum use of limited land without leaving the land as wasteland. He is happy and satisfied with farmer profession.

**4.5.9 “Suanlungthod Banana Orchard” 43 Moo 5, Nong Sam Wang
Subdistrict, Nong Suea District, Pathum Thani**

Table 4.7 Owner: Mr. Theerapong Suksawang

No.	Qualifications	Findings
1.	Knowledge and Understanding of The Current Activity	Can serve as lecturer to transfer technology or give advice to other farmers or interested public. Used to participate in Young Smart Farmer project by Nong Suea Agricultural Extension Office, Pathum Thani. Can also serve as model farmer or point of learning to other farmers or interested public.
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Know and regularly contact officials of Ministry of Agriculture and Cooperatives to make inquiries. Recording of information via Smart Phone. Use the information to analyze and plan prior to operation and undertake farm output management in line with the demand of market and consumers. The information is used to solve problems and develop his own profession by using the income-expenditure account in various periods to plan production in line with customers' demand.
3.	Output and Marketing Management	Able to connect production and marketing to sell output. Zero Waste Management. Waste is when the bunch of bananas come out, it is necessary to cut off the trunk or trim the trunk while cutting off leaves. The cut off trunk is left at the base of the new banana tree and the leaves are used to cover soil and degrade into fertilizer in the end without destroying the environment.
4.	Awareness of Product Quality and Consumer Safety	At present, collects over 170 banana varieties. The difficulty is not only the rarity but sometimes for the same banana variety it is called differently depending on

No.	Qualifications	Findings
		provinces or regions. If farmers or interested public wish to grow the banana varieties sold by the farm, to ensure quality goods, he recommends them to buy at the known and trusted farm.
5.	CSR	Production process does not generate pollution and does not destroy environment (Green Economy). In the farm, there is no waste. He does not use chemicals but he uses organic fertilizer pellets and chicken droppings mixed with husk instead.
6.	Pride of Being Farmer	Committed to practice farmer profession with 100% dedication. He wants to develop more banana varieties. He loves and cherishes the land and farmer profession for the next generation. He is happy and satisfied with the profession.

4.5.10 “Suanpanisara” Dates and Gimju Guava, 99/1 Moo 8, Nong Kai Subdistrict, Kratumban District, Samut Sakhon

Table 4.8 Owner: Ms. Panisara Thongsima

No.	Qualifications	Findings
1.	Knowledge and Understanding of The Current Activity	Able to serve as lecturer to transfer technology or give advice to other farmers or interested public. Lecturer to create supplementary profession, increased output, processing, increased output value to Krathum Baen Local Subdistrict Administration, Bansomdejchaopraya Rajabhat University, Samutsakorn Community College. Also model farmer or learning point for other farmers or interested public. Demonstration plots and one of the model plots to increase agricultural products of the village, subdistrict, and Krathum Baen District Agricultural Extension Office, Samut Sakhon.

No.	Qualifications	Findings
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Able to use Smart Phone to search for information on increased value of agricultural products. Recording of information and use the information to accompany the analysis and planning prior to operation. Farm output management in line with the demand of market and consumers. Mostly used in marketing planning during the launch of new products to see the trend of the goods.
3.	Output and Marketing Management	Zero Waste Management from guava juice. The pomace will be used to produce jam. Pruning. Guava leaves will be processed into fabric according to the BCG principles. Gimju guava can all be sold. Clear orders in advance so that she is able to plan continuous production.
4.	Awareness of Product Quality and Consumer Safety	Guava orchard based on bio farming with focus on reduced costs, high amount of production, focus on safety of growers, consumers, and products. Certified with G.A.P. standard. The farm is knowledgeable and trained on the standards of Organics Thailand, G.A.P., G.M.P.
5.	CSR	Production process that does not generate pollution and does not destroy the environment (Green Economy). Reduced pollution by reduced use of chemicals and increased use of herbs. Continuous CSR activities through trainings on techniques of tie dye cloth with guava leaves since 2019. Local farmers are invited to join the agro-tourism to see the livelihood of fruit growers with focus on tourist participation, activities that encourage learning on agriculture, lifestyle, culture, tradition, and utilization of existing resources to generate income for the community and the farmers themselves.
6.	Pride of Being Farmer	Committed to farmer profession. Use the principle of reduced production costs as

No.	Qualifications	Findings
		much as possible. Livelihood based on sufficiency. Love and cherish land and farmer profession for the next generation. Set an example through behavior and practice to show her daughter that farming is a profession that is self-sustaining and that one is the master of one's profession without having to work for others. With sufficient ability, one can enhance on the agricultural business. Happy and satisfied with farmer profession.

4.5.11 “Pitak Mushroom Farm” 45 Moo 5, Tha khai Subdistrict, Mueang Chachoengsao District, Chachoengsao

Table 4.9 Owner: Mr. Pairoj U-pitak

No.	Qualifications	Findings
1.	Knowledge of The Current Activity	Can be model farmer or point of learning for other farmers or interested public. The Mushroom Farm is also a mushroom learning center. Department of Non-Formal Education, Subdistrict Administration Organization and schools send people in group to study and learn the method of producing mushroom spawn, processing of fried mushroom, fermented mushroom, deep fried mushroom in sweet and salty sauce.
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Use Internet through devices to search agricultural information. Record information and use the information to analyze and plan before operation. Manage farm output in line with the demand of market and consumers. Record to plan production all the time. Information is used to solve problems and develop his own profession in

No.	Qualifications	Findings
		terms of production and distribution.
3.	Output and Marketing Management	Able to manage factors of production, labor force, and capital. In terms of labor force management, instead of hiring regular workers, the method of lump sum per work piece is used to reduce costs and shorten time. Able to connect production and marketing to sell output in line with the demand of customers. Processing of lingzhi into fried mushroom, deep fried mushroom in sweet and salty sauce, etc. Zero Waste Management. The expired spawn is used as fertilizer and for the cultivation of lemons.
4.	Awareness of Product Quality and Consumer Safety	Stress importance of cleanliness in every stage of production. The steaming oven of mushroom spawn was invented and developed by the owner to steam the raw material used of mushroom spawn cultivation for cleanliness and good quality for consumer safety. The farm mushroom is certified with the G.A.P. standard. The farm owner attended trainings on the Organics Thailand standard, G.A.P., G.M.P. Continuous CSR. Open farm as learning center for interested people. Mostly coordination from Department of Agricultural Extension or various agencies who make contact.
5.	CSR	
6.	Pride of Being Farmer	Committed to practice farmer profession. Highly satisfied with return in farmer profession. Love and cherish the land and wish that the profession of mushroom farm belongs to the next generation of the family members.

**4.5.12 “Lertphol Riceberry” 26 Moo 1, Mahasawat Subdistrict,
Phutthamonthon District, Nakhon Pathom**

Table 4.10 Owner: Mr. Chaisri Loonlertpol

No.	Qualifications	Findings
1.	Knowledge of The Current Activity	Able to be lecturer to transfer technology or give advice to other farmers or interested public. Model farmer or point of learning of natural farming without the use of chemicals. Knowledge on rice farming with the organic G.A.P. quality standard, reduce costs, and develop rice quality. Riceberry rice cultivation by parachute seeding. Improved soil quality. Composting.
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Efficient use of Smart Phone through Line program to sell riceberry rice to customers. Recording of information and use of the information to analyze and make planning before operation. Management of farm output in accordance with the demand of market and consumers. Use of the information to solve problems and develop his own profession. Current practice of integrated farming because in the past it was difficult to practice only rice farming as the tractor owner who brought rice variety suspended operation.
3.	Output and Marketing Management	Able to manage factors of production, labor force, and capital. The farm received budget support of 478,000 baht (Four hundred seventy-eight thousand baht) from Provincial Energy Office-Nakhon Pathom which saves electricity bills. Use of alternative solar energy. Able to connect production and marketing to sell output. Apart from riceberry rice cultivation, additional integrated farming is practiced on 3 rai of land for cultivation of Gimju

No.	Qualifications	Findings
4.	Awareness of Product Quality and Consumer Safety	guava and aromatic coconut. Knowledgeable or attended trainings on standards of Organics Thailand, G.A.P., G.M.P. Knowledgeable on rice farming according to the organic G.A.P. quality system, reduced costs, development of rice quality, riceberry rice plantation by parachute seeding, improvement of soil quality, and composting. The guideline of organic farming in riceberry rice plantation ensures safety for both growers and consumers.
5.	CSR	The farm places importance on the environment with the concept that what one takes from nature, one has to give back. For example, for riceberry rice cultivation, after harvest, there is no burning of rice straw without taking anything out. Rice stubble will be left in the field and degrade into fertilizer while waiting for rice cultivation in the next cycle. The production process does not generate pollution and does not destroy the environment (Green Economy). Moreover, continuous CSR activities are undertaken by inviting many local farmers for joint riceberry rice plantation. The riceberry rice mill is also set up to accommodate the farmer groups.
6.	Pride of Being Farmer	Committed to farming profession. Produce quality products taking into account customers. Honesty with consumers. Love and cherish the land and farming profession for the next generation.

**4.5.13 “Pomelo Orchard Sampran” 9/1 Moo 4, Bang Toei Subdistrict,
Sampran District, Nakhon Pathom**

Table 4.11 Owner: Mr. Uttapol Polachai

No.	Qualifications	Findings
1.	Knowledge of the Current Activity	Able to be lecturer to transfer technology or give advice to other farmers or interested public. Cooperation with public and private sectors to serve as lecturer in various fields such as care of fruit trees after receded floods, production and use of Trichoderma spp. It is the orchard that initiates organic farming while neighboring orchards still practice chemical farming, as a model orchard.
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Know and regularly contact officials of Ministry of Agriculture and Cooperatives to inquire about information. Use of Internet via various equipment to efficiently search agricultural information. Recording of information and use of the information to analyze and make planning before operation. Farm output management in line with the market and consumers from the recorded information. Farm output is relatively hard hit by COVID-19. The information is used to solve problems and develop own profession. Fruit orchard farming will not receive regular return every year due to climate variability in contrast with the past 20 years when the target is relatively met.
3.	Output and Marketing Management	Able to manage factors of production, labor force, and capital, etc. The owner works on his own. He hires additional external labor force to cut grass, during harvest, and heavy loading. Efficient output management. Integrated farming. Apart from pomelo, other plants are grown to increase income all year round such as lemon, betel nut. Zero Waste Management in the farm. Farm

No.	Qualifications	Findings
		that initiates organic farming so there is no waste or chemicals.
4.	Awareness of Product Quality and Consumer Safety	He improved the area because in the old area, there had been no farming for a long time. He started by bringing in a bulldozer for soil conditioning in parallel with plant cultivation. Farmyard manure and soil-enriching organic fertilizer were used. The concept of organic farming is not to use chemicals to maintain the soil condition and preserve the environment, as well as for his own health and that of the consumers.
5.	CSR	Integrated farming is practiced with cultivation of many plants such as pomelo, banana, coral tree, and wild betel leafbush through optimum land use. Use of microbial pesticide. Fertilizer is made for own use. Environmental-friendly production process that does not generate pollution or destroy the environment (Green Economy).
6.	Pride of Being Farmer	Committed to practice farmer profession. Determined to follow the Sufficiency Economy principle, without using chemicals, for his own safety and that of consumers. Love and cherish the land and farming profession for the next generation.

**4.5.14 “Palmyra Palm Phetchaburi”21 Moo 2, Tham Rong Subdistrict,
Ban Lat District, Phetchaburi 7610**

Table 4.12 Owner: Mr. Suriya Choowong

No.	Qualifications	Findings
1.	Knowledge of The Current Activity	Able to serve as lecturer to transfer knowledge or give advice to other famers or interested public to acquire knowledge, techniques, and agricultural methods, in-depth knowledge on plants, as well as recording of agricultural

No.	Qualifications	Findings
		information, income-expenditure accounting.
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Modify the duration of the banana cultivation or harvest for appropriateness. Based on the information analysis, it can be confirmed that if the information is used to solve problems and develop his own profession, it will increase output or income.
3.	Output and Marketing Management	Plan production, marketing, and search for methods to reduce production costs to forge caution in profession and systematic planning of family's expenditure. Plan production in advance in line with the demand of the market such as banana cultivation for the output to come out at the time of the Chinese New Year.
4.	Awareness of Product Quality and Consumer Safety	Knowledge and trainings on the Organics Thailand, G.A.P., G.M.P. standards with cultivation of chemical-free fruits certified with the G.A.P. for plant. Produce bio fertilizer, bioextract, output certified with the standards of agricultural product and food or Q logo to ensure confidence of consumers on food safety and quality.
5.	CSR	Production process that does not generate pollution and does not destroy environment (Green Economy). Learning from real practice on the land of 1 6 rai. Integrated farming with cultivation of rice and toxic-free fruits. Leader and model of livelihood according to the Sufficiency Economy philosophy and integrated farming according to the new agricultural theory. Time management. Work for the benefit of the public and the community. Good example in livelihood recognized by

No.	Qualifications	Findings
6.	Pride of Being Farmer	community residents. Inherited agricultural land from the old generation to the next and teach household members to love and cherish the land and farming profession.

**4.5.15 “Pin-Chai Date Orchard” 13/1 Moo 3, Nang Kaeo Subdistrict,
Photharam District, Ratchaburi**

Table 4.13 Owner: Mr. Chatchai Saengcharoen

No.	Qualifications	Findings
1.	Knowledge of The Current Activity	Invited to be lecturer in various forums and ready to transfer technology or give advice to other farmers on date cultivation.
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Undertake recording or household accounting to plan financial matters and record information on production, harvest, and sales of agricultural products. Use of Internet, Smart Phone via various Applications such as Facebook and Line which greatly contribute to good marketing PR. Record information and use the information to analyze and plan output management in accordance with the demand of market and consumers. Use the information to solve problems and develop his own profession.
3.	Output and Marketing Management	Plan marketing to sell output into 4 parts namely in front of the orchard, online, Talaad Thai Wholesale Market, and sales to processed companies to produce canned beverage. Moreover, there is Zero Waste Management. Excessive farm output will be processed into preserved dates.
4.	Awareness of Product Quality and Consumer Safety	Participated in the Smart Farmer project with Photharam Agricultural Office in Ratchaburi and acquired knowledge from trainings on the Organics Thailand, G.A.P.,

No.	Qualifications	Findings
5.	CSR	G.M.P. standards. Production process that does not generate pollution and does not destroy environment (Green Economy). At present, local farmers group together to grow dates on the area of over 20 rai and the output starts to come out to the market. Focus on integrated farming in the date plots.
6.	Pride of being farmer	Committed to practice farming profession with dedicated study on the varieties, insects, and pests until he acquires clear knowledge and understanding. Love and cherish of land and farming profession for the next generation. Happy and satisfied with farming profession.

4.5.16 “Bangkachao Farm” Soi Phetcha Hueng 21/1, Bang Yo Subdistrict, Phra Pradaeng District, Samut Prakan

Table 4.14 Owner: Mr. Thaweesak Ong-Eiam

No.	Qualifications	Findings
1.	Knowledge of the Current Activity	Serve as model farmer or learning point to give advice to other farmers or interested people. Serve as lecturer to transfer technology to farmers or other public and private agencies. At present, MOU project with PTT on Smart Farming with fertilizer from waste.
2.	Information to Accompany Decision-Making on Production and Marketing Systems	Good understanding of Smart Farming. Record information and use the information to analyze and plan before starting operation. Farm output management in response to the demand of market and consumers. Use the information to solve problems and develop his own profession. Salad cultivation time is modified. Worm breeding or mushroom collection is

No.	Qualifications	Findings
		appropriate based on the information analysis which can be confirmed that the use of the information in solving problems and developing his own profession will increase output or income.
3.	Production and Marketing Management	Farm is able to efficiently manage factors of production, labor force, and capital. Apply IoT to work with watering controlled by Smart Phone. Also plan marketing, advertisement, and public relations by social media. Sales that meet the target. Zero Waste Management.
4.	Awareness of Product Quality and Consumer Safety	Bangkachao Farm is the only farm in the province certified with the Organics Thailand standard. Focus on safety for growers and consumers. Farm management includes the optimum equipment utilization without the use of chemicals. Reduced waste to be part of production chain. Reduced use of energy for clean environment.
5.	CSR	Bangkachao Farm owner stresses the importance of household waste which is food scrap waste at home by modifying the miniature waste disposing machine for compost processing within 24 hours. He works with the microbes invented by himself. Continuous CSR activities. Project to create profession for community residents for worm breeding. This project is supported by Phra Pradaeng Community Development Office. The production process in the farm does not generate pollution and does not destroy the environment (Green Economy).
6.	Pride of Being Farmer	Commitment in practicing farmer profession by focusing on cultivation for household consumption, the rest is for sales to increase income. Love and cherishment of the land and agricultural profession to

No.	Qualifications	Findings
		hand over to the next generation, as well as good environmental management.

4.6 Key Success Factors of Smart Farming

Based on the analysis of the 10 case studies of those who practice Smart Farming, the key success factors of Smart Farming: Study of Model of Smart Farming in Urban Community revealed the shared factors as in Table 4.15

Table 4.15 Study Results of the Shared Success Factors of Smart Farming

Shared Factors	Chokanan Farm	Melon & Salad Farm	Suanlungthod Banana Orchard	Suan Panesar	Pitak Mushroom Farm	Lerphol Riceberry	Pomelo Orchard Samphan	Pin-Chai Date Orchard	Pin-Chai Date Orchard	Bangkachao Farm	Total
1. Commitment and determination	X	X	X	X	X	X	X	X	X	X	10
2. Ability to use IT devices	X	X	X	X	X	X	X	X	X	X	10
3. Ability to plan marketing and online marketing	X	X	X	X	X	X	X	X	X	X	10
4. Training attendance for additional knowledge	X	X	X	X	X	X	X	X	X	X	10
5. Recording, income-expenditure accounting	X	X	X	X	X	X	X	X	X	X	10
6. Sufficiency Economy farming, organic farming, and integrated farming	X	X	X	X	X	0	X	0	X	X	8
7. Support from the public, business, and private sectors	X	X	0	X	X	X	X	X	0	X	8
8. Knowledge of farming from ancestors	0	X	X	X	0	X	X	X	X	X	8
9. Output certified with G.A.P. standard	0	X	X	X	X	X	0	0	X	X	7
10. Forming of farmer groups for joint farming practice	0	0	0	X	0	X	X	X	X	0	5

Summary of the Key Success Factors of Smart Farming With Ranking 1-10
As Follows:

- 1) Commitment and determination
- 2) Ability to use IT devices
- 3) Ability to plan marketing and online marketing
- 4) Training attendance for additional knowledge
- 5) Recording, income-expenditure accounting
- 6) Sufficiency Economy farming, organic farming, and integrated farming
- 7) Support from the public, business, and private sectors
- 8) Knowledge of farming from ancestors
- 9) Output certified with G.A.P. standard
- 10) Forming of farmer groups for joint farming practice

Summary of the Common Key Success Factors of Smart Farming With Ranking 1-10 As Follows:

In order to obtain in-depth information on Smart Farming in urban community from the farmers in the pilot case studies, the researcher was kindly allowed to conduct Structured Interview and observation by undertaking study tours of Smart Farming in urban community with 10 key informants as follows:

4.6.1 Commitment and Determination

Commitment and determinations constitute a crucial principle for the success of farmers who wish to practice Smart Farming. Without commitment and determination, it will be difficult to succeed. Because Smart Farming has processes and technology, without determination, one may get discouraged, leading to failure. The qualification item 6 of Smart Farming identifies the pride of being farmer and the indicator is commitment in practicing agricultural profession, love and cherish the land and farming profession for the next generation, and happy and satisfied with the farming profession (Department of Agriculture Extension, 2022). Based on the study: Case study 1 Hydroponics Vegetable Farm relied on strong commitment and determination because the owner had no previous knowledge or experience in farmer profession. He had to diligently seek additional training and knowledge before

starting operation. Case study 2 Melon Farm faced the problem that the pests destroyed his output and the problem of shortage of clean water in the farm. He managed to solve the problems due to his commitment and determination without giving in to problems and obstacles. Case study 3 Suanlungthod Banana Orchard faced the problems and obstacles from practicing orange orchard from his parents who experienced problems from epidemics and pesticides as well as debt burden. They were the driving force of persistence to practice the banana orchard with culture propagation of banana and to succeed. Case study 4 Guava Orchard: From the experience of the former background of family orchard, the owner did not give in to problems and was committed and determined to succeed by making a trial to grow new types of plants such as dates and open the farm for agro-tourism without fear of obstacles. Case study 5 Mushroom Farm similarly to Case study 1 Hydroponics Vegetable Farm the owner had no previous knowledge on farmer profession but was highly committed and determined to seek additional knowledge by himself before starting operation. It was the beginning that required high perseverance, commitment, and determination. Case study 6 Riceberry rice, Case study 7 Pomelo Orchard, Case study 8 Integrated Agricultural Garden, Case study 9 Date Orchard, and Case study 10 Bangkachao Farm: Although the 5 case studies followed farming profession after their ancestors, the lack of commitment and determination to manage Smart Farming makes it difficult to cope with problems and obstacles to succeed. It is the farming profession that requires complete dedication to work, including physical, mental, and time to make farmer profession succeed and fulfill the goals. When encountering problems or obstacles, they will strive to solve the problems without giving up. If not successful, they will strive to find the real reason of the cause of the problems, whether it comes from mistakes from work or from other environmental conditions. Even if with complete determination, they still fail, they will know the cause of the failure. Commitment and determination constitute therefore a major principle to make the profession succeed.

4.6.2 Ability to Use IT Devices

The farmers practicing Smart Farming experience the details and processes of farming that is different from traditional farming especially technology that requires

knowledge from the use of IT tools as a crucial device that will make Smart Farming succeed according to the concept of IT technology and agricultural development of Ploonsakul (2013) who identified agricultural IT as the major foundation and necessity that is indispensable in the development of Thailand's agriculture. IT is the background of knowledge and technology that will create value added and develop knowledge in terms of production, marketing management, and product processing. To ensure that the development of agricultural IT is truly useful, it is necessary to operate systematically in the form of cooperation network of IT producing agencies both public and private as well as IT users both organization or individual. IT technology can be applied for agricultural benefit especially agriculture with the application of agricultural IT technology such as IoT (Internet of Thing) to assist Smart Farming in terms of control of temperature, humidity, provision of water and fertilizer, use of sensors to measure information such as Weather Station, Soil Sensor, Plant Disease Sensor, Yield Monitoring Sensor, etc. The objective is to increase efficiency in production and agricultural output for farmers from reception of agricultural information, prices of agricultural output, and demand of agricultural output in the market which will help farmers make better decision on production and can produce in response to the market demand. The examples include the following:

Case study 1 Hydroponics Vegetable Farm and Case study 5 Mushroom Farm: The owners did not have previous knowledge or experience in practicing farming but highly succeeded in farming profession by using IT devices such as Smart Phone to search for additional knowledge on farming profession, as well as Personal Computer to plan marketing, advertisement and public relations. The devices were used to record information, statistics, prepare income-expenditure account, compile information for analysis and use the analytical results to assist in decision-making, plan operation, and for the provision of water and fertilizer. Case study 2 Melon Farm: The owner also used the IoT device to report the water result through Smart Phone system. The clear benefits of the ability of Smart Phone, and Personal Computer, for the 10 case studies are to assist in planning of production, marketing, public relations, and online marketing via Application Facebook to assist the sales of output to be directly delivered to customers and consumers with ease, convenience, and speed. They allow farmers to sell more output. The farmers also know the

information about customers' future demand in order to plan production in line with the demand of customers and consumers with clarity and completeness.

4.6.3 Ability to Plan Marketing and Online Marketing

The importance of marketing planning of Smart Farming is to generate income for farmers to sell their output, create the guideline to regularly develop and improve output in line with the demands of the market and consumers, expand production with various advantages for customers which make customers and consumers require goods and output from Smart Farming. Competitive advantage should be created in terms of social media which can be used as strategy to respond to the needs of present consumers. Because at present, communication technology is developed. As a result, agricultural business has to adapt itself. It leads to marketing through social media to support consumers' behavior with increased use of social media. Presently, marketing through social media has a very important role for Smart Farming. It can clearly identify the target consumers, and send agricultural information and news directly to the target groups. Therefore, the strategy to create competitive advantage in terms of social media will make entrepreneurs of Smart Farming more competitive in terms of marketing costs as online marketing has lower costs than other marketing channels. Smart farmers can undertake it themselves which can reduce operating costs as selling promotion of agricultural goods. Moreover, entrepreneurs of Smart Farming can introduce agricultural goods and respond to the needs of consumers through marketing of specific customer group by using social media such as Facebook, Twitter, and YouTube. They allow entrepreneurs of Smart Farming to know the consumer groups who are interested in agricultural products, can respond to the needs of the specific target groups (Rungrat Chisumreth, 2012), conveniently and timely gain access to consumers, can answer, converse, and express feelings during a short period, resulting in the fact that Smart Farmers can sell their output according to the goals. The examples are the following: Case study 1 Hydroponics Vegetable Farm: Prior to production process, the owner would look for customers to acquire orders first before starting production. Thus, the output could be completely sold. The information would be recorded as statistics to analyze and accompany decision-making in planning of future marketing. Case study 2 Melon Farm: The owner

planned marketing, advertisement and public relations to produce output in line with the demand of both online and walk in customers who visited the farm as agro-tourism. The information would be used to analyze and accompany decision-making on future planning of marketing. Case study 3 Suanlungthod Banana Orchard: The owner would record information and statistics for analysis and data processing to plan marketing to ensure that the production of banana shoots was in line with the demand of customers whether rare varieties or preserved varieties were available for sales all the time. The owner also used online market to publicize and conduct PR to assist in the sales. Case study 4 Guava Orchard: The owner planned marketing, advertisement and public relations to produce goods that respond to the needs of online and walk in customers who visited the Guava Orchard as agro-tourism jointly held with Nong Nok Khai community enterprise, Nong Nok Khai Subdistrict, Krathum Baen District, Samut Sakhon. Case study 5 Mushroom Farm: The owner planned marketing of mushroom, and spawn. The production would be consistent with the recorded information and statistics to analyze and use online market to advertise and conduct PR to sell mushroom and other output in the farm. Case study 6 Riceberry rice: The owner planned marketing from the information that he received by selling the output by himself and directly communicating with customers. The acquired information of the customers' needs would be analyzed to plan marketing in response to the target groups including riceberry rice, aromatic coconut, Gimju guava, and used online market to advertise and conduct PR for the sales of farm output. Case study 7 Pomelo Orchard: The owner planned marketing in conjunction with middleman who came to take the farm output for export whether in each period there was a big or small demand of particular goods. Case study 8 Integrated Agricultural Garden: The owner had good knowledge and experience in marketing planning and production planning to ensure consistent output such as cultivation of bananas so that they could be on sale during the Chinese New Year. The owner was also leader who invited local farmer group to attend the meeting and learn about marketing planning for the production of agricultural output in order to be in line with the demand of market and consumers. Case study 9 Date Orchard: The owner used the recorded information to analyze and accompany the decision-making on future marketing planning, used online market to sell output, and advertised and conducted PR by inviting customers and interested

people to visit the Orchard as agro-tourism. Case study 10 Bangkachao Farm: The owner planned marketing, and advertised and conducted PR to produce output and goods in accordance with the needs of both online and walk in customers who visited the Farm as agro-tourism. Only the following case studies namely: Case study 1 Hydroponics Vegetable Farm, Case study 7 Pomelo Orchard, and Case study 8 Integrated Agricultural Garden where the owners had not undertaken online marketing. In the future, it is undeniable that the farmers who practice Smart Farming must take into consideration the importance of online marketing in parallel with familiar market. If the farmers do not adapt themselves, they cannot increase sales and output. Their competitors will snatch their market share. It will certainly impact the survival of the farmers who practice Smart Farming if the farmers do not adapt themselves to seriously deal with the trend of online market.

4.6.4 Training Attendance for Additional Knowledge

Smart Farming necessitates additional knowledge. So, training is important to support, promote, and develop farmers in their practice of Smart Farming. The training will provide knowledge, ability in production, management, marketing, digital skills, use of appropriate technology, self-adaptation under changing situations, as model farmer who can transfer knowledge to other farmers and encourage the new generation to enter the agricultural sector and to be developed into Young Smart Farmer. The development process is arranged and the network is systematically created. The use of ICT (Information and communication technology) is supported. New technology, innovation, and creativity are developed to upgrade into agricultural entrepreneurs and the driving force of the development of new agriculture by integrating with all relevant sectors (Department of Agriculture Extension, 2022). The trainings and seminars organized by the public and private sectors will provide knowledge and understanding of the farmer profession to succeed which is extremely useful for Smart Farmers who have the opportunity to attend the trainings as they will know the changes and trend that they have to adapt themselves and handle with uncertain situations, and learn about advanced science and technology to be applied in operation planning, as well as marketing and production planning. The examples of the case studies are as follows: Case study 1 Hydroponics Vegetable Farm: The

owner was interested in attending trainings and seminars for knowledge and advanced technology on agriculture regularly held by both the public and private sectors such as academic training on agriculture at Department of Horticulture, Faculty of Agriculture, Kasetsart University, Kamphaeng Saen Campus. Case study 2 Melon Farm: The owner provided the location and attended the training with Agricultural Productivity Efficiency Increasing Learning Center which is the center to transfer technology on production, management, and marketing for farmers. Case study 3 Suanlungthod Banana Orchard: The owner was enthusiastic to attend the training on Young Smart Farmer of Pathum Thani every time. Case study 4 Guava Orchard, Case study 5 Mushroom Farm, Case study 6 Riceberry rice, Case study 7 Pomelo Orchard, Case study 8 Integrated Agricultural Garden, and Case study 10 Bangkachao Farm: The owners served as lecturers and attendees of agricultural training regularly organized by Department of Agricultural Extension, Ministry of Agriculture and Cooperatives such as training on the knowledge of organic farming. Knowledge on modern agricultural science and technology acquired from the trainings were developed, enhanced, improved, and applied in the farms, resulting in the changes in output with increased factors of production.

4.6.5 Recording and Income-Expenditure Accounting

Recording and income-expenditure accounting for Smart Farmers is a good indicator for practicing the profession. Income-expenditure recording will ensure that the farmers know where the money comes from and how much and know where the expenditure goes and how much. According to the Sufficiency Economy principle, accounting is extremely important because it shows financial security. To ensure security, everyone must know how to correctly and appropriately spend money and must save in case of emergency. His Majesty the Late King Bhumibol Adulyadej was concerned with the problems of poverty and livelihood of his subjects as seen by his royal remark on accounting (Office of the Non-Formal and Informal Education, Ministry of Education, 2011, p. 4). Therefore, to ensure sustainable agricultural development, income-expenditure account is a major tool that will help farmers follow up and plan expenditure, control production costs, and know unnecessary expenditure that can be reduced to increase savings and increase ability to pay their

debts (Pimrak Phumcharern, 2016). The examples of the case studies are as follows: Case study 1 Hydroponics Vegetable Farm: The output was mostly exported to Europe. Income-expenditure accounting was crucially important, especially to use the information for risk analysis during the period of fluctuating foreign exchange rates which involved many factors. It would benefit the planning of production in accordance with the demand of the market. Case study 2 Melon Farm, Case study 4 Guava Orchard, Case study 9 Date Orchard, and Case study 10 Bangkachao Farm: The owners undertook clear recording and income-expenditure accounting to compare the statistics of the online sales and the sales to customers in front of the farm. Case study 3 Suanlungthod Banana Orchard, Case study 5 Mushroom Farm, Case study 6 Riceberry rice, and Case study 7 Pomelo Orchard: The owners undertook recording and general income-expenditure accounting. The recording of financial information from operation both income and expenditure was to ensure that the owners had financial information and operation results of how much the money was left and compared the operation results if they had profit or loss. Case study 8 Integrated Agricultural Garden: The owner applied production technology in the management of financial system with household accounting and marketing by studying the market demand and checking the prices of fruits and vegetables that were different depending on festivals and seasons in order to plan monthly cultivation appropriate to market demand in the particular period. The recorded account information was used to analyze production planning in order to see the problems and solutions and developed himself until he met with success. Similarly to someone with good knowledge, understanding, and accounting ability, it would ensure progress and security in operation, resulting in enabling agricultural output to pass the risk of market mechanism with impact on pricing of agricultural yields and still use the information from the account recording to manage the factors of production such as soil, water, and fertilizer in an appropriate manner until passing the crisis.

4.6.6 Sufficiency Economy Farming, Organic Farming, and Integrated Farming

Smart Farming applies the knowledge on successful and useful agricultural practice in terms of production and environmental sustainability in many guidelines

that are compiled such as Sufficiency economy farming that His Majesty the Late King Bhumibol Adulyadej who graciously bestowed the concept of new agricultural theory which was simple, and uncomplicated agricultural methods in accordance with livelihood and the overall eco-system of nature, with the circular, optimum resource utilization. Organic farming is the agricultural system that produces food based on environmental, social, and economic sustainability by focusing on the principle of soil improvement, respect of natural potentials of plants, animals, and eco-system, reduce the external factors of production without using agricultural chemicals, including chemical fertilizer, pesticides, as well as synthetic hormones that stimulate the growth of plants and animals, and highest importance placed on soil improvement. It is believed that rich soil will enable the plants and animals that grow on the land to be abundant accordingly. Integrated Farming System is the agricultural system with cultivation of plants or breeding of animals that are different on the same land under mutual assistance for the highest efficiency. The focus is on co-existence between plants, animals, and environment probably in the form of relationship between plant and plant, plant and animal, or animal and animal with importance placed on each activity appropriate to physical environment. Of 10 case studies of Smart Farming, 5 cases undertook Sufficiency Economy farming, organic farming, and integrated farming as follows: Case study 4 Guava Orchard: In terms of agricultural principle, the owner used the Sufficiency Economy guideline to allocate land and manage water for cultivation of fruits and organic farming without the use of chemicals, as well as integrated farming of plants such as Gimju guava, date, rose apple in the plots. Case study 6 Riceberry rice: As for the agricultural principle, the owner used the Sufficiency Economy guideline for land allocation and optimum land use to grow riceberry rice and practice organic farming without using chemicals, as well as integrated farming of plants such as Gimju guava, aromatic coconut, and rose apple in the plots, ensuring income from numerous sources. Case study 7 Pomelo Orchard: The owner practiced integrated farming with the cultivation of betel nut, and lemon together with pomelo. He also had good knowledge on organic farming. The concept of organic farming was not to use chemicals to maintain soil conditions and environment, as well as fertilizer and pesticide. Case study 8 Integrated Agricultural Garden: The owner used the Sufficiency Economy principle as the guideline for

farmer profession namely 1. Moderation 2. Reasonableness 3. Self-immunity. He started by growing many fruit trees such as palmyra palm, green rose apple, Cavendish banana, aromatic coconut, durian, papaya, and sapodilla. He grew them in an integrated and rotating method. Together with the guideline of organic farming, he produced biofertilizer and bioextract. Case study 10 Bangkachao Farm: The local farmers grouped together and started organic farming in 3 batches totaling 30 farmers called “Khung Bangkachao Organic Farming.” Bangkachao Farm was the only farm in Samut Prakan certified with the Organics Thailand standard.

4.6.7 Support From the Public, Business and Private Sectors

Smart Farming is an undertaking with large investment requiring large budget to operate and monitor until the output reaches the determined target. At present, farmers who practice Smart Farming without prior foundation need to be supported by the government in terms of knowledge and budget until they succeed in the practice of Smart Farming. Up till now, the government by Ministry of Agriculture and Cooperatives formulates the Action Plan on Smart Farming 2022-2023 based on Thailand 4.0 Policy and the 20-Year National Strategy with the formulation of agricultural master plan and minor plan on smart farming under the strategy to increase competitiveness of which Ministry of Agriculture and Cooperatives formulates the policy to drive smart farming to upgrade farmers' quality of life by using technology to support agricultural production process, improve present farming to move towards Agriculture 4.0, and apply innovation and technology to develop future Smart Farming. Apart from government agencies, there is also the state enterprise, PTT Plc. The company organizes PTT Innovation for Happiness Project which is innovation and technology of PTT Group for agricultural new normal aiming to develop social business on new agriculture through the application of innovation and technology on international management and increased income from productivity. The private sector who supported Smart Farming consisted of 3 interesting companies as follows: 1) Advanced Info Service Public Company Limited with the project AIS iFarm. It involves the development of central platform on the cloud to compile information, analyze, and automatically order the IoT equipment. This is ensure that the farmers wishing to improve their own cultivation areas into Smart Farming can do

so by installing Sensor and set the initial value without developing any program by themselves for easy use at work 2) Total Access Communication Public Company Limited has the function “Precision Farm Service” as a tool to forecast accurate weather and assist farmers in cultivation management more efficiently, which was already tested with the pilot farmers in 2018. The precision farm services consist of 3 major features namely area-specific weather forecast with the ability to show the area-specific results requiring the hour, temperature, possible rainfall, and amount of rainfall in the area 3.Siam Kubota Corporation Co., Ltd. “Kubota Farm” derives from applying knowledge on integrated smart farming which is unique to Kubota or Kubota Agri Solution (KAS) to the 10 zones on the area of 220 rai in Chon Buri designed under the developmental concept from upstream-downstream to serve as the model farm to transfer learning to farmers in order to use agricultural machinery and solutions and develop to high-income farming, modern precision farming, and holistic economic development or BCG Model.

The public and private support in terms of knowledge, budget, and input allocated to the farmers who practice Smart Farming include the following: Case study 1 Hydroponics Vegetable Farm was supported by Samut Songkhram Provincial Agricultural Extension Office in terms of technical information and methods of vegetable farming until reaching success by successfully requesting the certification of the Global G.A.P. standard. Case study 2 Melon Farm was supported for the automatic farm control system by Hydro-Informatics Institute (Public Organization). Case study 3 Suanlungthod was supported for knowledge on cultivation of banana shoots for sale by Pathum Thani Provincial Agricultural Extension Office. Case study 4 Guava Orchard was supported by Department of Agricultural Extension to set up community enterprise Ban Nong Nok Kai, Nong Nok Kai Subdistrict, Krathumban District, Samut Sakhon. Case study 5 Mushroom Farm was supported by Chachoengsao Provincial Agricultural Extension Office as a center for community knowledge. Case study 6 Riceberry rice was supported budget as a rice mill from Nakhon Pathom Provincial Energy Office. Case study 7 Pomelo Orchard was supported by Nakhon Pathom Provincial Agricultural Extension Office as the learning center of organic farming. Case study 9 Date Orchard was supported knowledge from Photharam Agricultural Office on date cultivation. Case study 10 Bangkachao Farm

was supported duck and chicken varieties from Samut Prakan Provincial Livestock Office, and the MOU Project with PTT on Smart Farming for fertilizer from waste and other agencies with MOU to organize numerous activities such as Kasetsart University, National Research Council of Thailand, Central Department Store, M.K. Real Estate Development Public Company Limited, Suan Sampran. They were all supported by the government in terms of knowledge, budget, and input for operation and succeed with commitment in practicing farmer profession.

4.6.8 Knowledge on Agricultural Practice from Ancestors

Most farmers who start their profession are motivated by their families or ancestors as they were born and raised in the farmer families and absorbed the farmer way of life since childhood and learned the processes of cultivation, sowing, plowing, tilling, or husbandry from their parents. It is the knowledge transfer from generation to generation through practice compared to knowledge from local wisdom. It is knowledge developed from mankind's science and knowledge. These knowledge and local wisdom result from the process of research and invention as continuously accumulated until they are recognized by the public as Traditional Knowledge specifically in each area or terrain derived from the use of skills, knowledge, and experience of people in the community or local people in learning and solving problems in living and succeeding from one generation to another (Natenapang Namjitthai, 2015). Local wisdom has always existed with livelihood or Thai society for a long time. Local wisdom is compared to historic evidence that tells the background and livelihood of people in community which is extremely useful for the next generation. Development of science and advanced technology results in many creativity and innovation that greatly benefit the global society. Most of these novelties derive from traditional knowledge or local wisdom by combining science and technology into new knowledge. It can therefore be said that local wisdom is crucial as the database that develops and enhances as new knowledge, innovative and creative works which are extremely beneficial (Suchada Charoenviriyatham, 2013). From the study, farmers practicing Smart Farming use knowledge from ancestors or local wisdom to practice farming profession with the following examples. Case Study 2 Melon Farm received knowledge from parents' real experience in rice cultivation.

Case study 3 Suanlungthod received knowledge from parents who failed in orange orchard before turning to banana orchard. Case study 4 Guava Orchard received knowledge of fruit cultivation from parents and enhanced on the activity for present cultivation of Gimju guava and date. Case study 6 Riceberry rice received knowledge on rice cultivation from parents. Case study 7 Pomelo Orchard received knowledge from paternal grandfather, father, and mother on fruit cultivation. Case study 9 Date Orchard received knowledge from parents on rice cultivation and vegetable farm. Case Study 10 Bangkachao Farm received knowledge from mother on practicing orange orchard. Only Case study 1 Hydroponics Vegetable Farm and Case study 5 Mushroom Farm did not inherit the farming knowledge from ancestors or from local wisdom. The presence or the absence of knowledge from ancestors or local wisdom to serve as the guideline of farming profession does not totally affect the success of the farmers practicing Smart Farming as there are many other relevant factors that impact the success of the farming.

4.6.9 Output Certified with G.A.P. Standard

Thailand is a major producer and exporter of agricultural products and food. But up till now, agricultural output and food are not totally safe for consumers due to residual chemicals, pests, and contaminated microorganism, causing the quality not to reach the standard. Therefore, farmers must be promoted to produce safe agricultural goods in accordance with quality management system of Good Agricultural Practices (G.A.P.) which is the system that prevents or reduces the risk of danger in agricultural goods and food. In terms of Good Agriculture Practices (G.A.P.) for plants, Department of Agriculture, Ministry of Agriculture and Cooperatives, is the agency responsible for inspection and certification of quality management system. G.A.P. for plants specifies the requirements, criteria, and method of assessment in line with international principles to serve as the standard to produce plants at the country's farm level, as well as prepares the manual of plant cultivation according to the G.A.P. principle for 169 varieties of major plants in Thailand such as fruits, durian, longan, dainty banana, pineapple, pomelo, mango, and orange; vegetables such as tomato, asparagus, kale, onion, cabbage, chili, cow-pea, green pea, Chinese cabbage, baby corn, onion, and spring onion; flowering plant, fresh cut orchid, and Siam Tulip; other

crops such as robusta coffee, cassava, rubber, etc. (Department of Agriculture Extension, 2022). The benefits of Smart Farming from the cultivation of plants according of the G.A.P. system include knowledge of systematic cultivation of plants, reducing production costs, correct method of eliminating pests, output with quality and safety from contamination of chemicals, diseases, and pests in demand in domestic and international markets, certified with production system and output that are recognized, output has quality, consumers have confidence, farmers and buyers consume safe vegetables and fruits with good quality causing good health, and regular income from sales of safe vegetables and fruits causing family warmth and prosperity for farmers. Of the 10 case studies, only one or Case study 1 Hydroponics Vegetable Farm was certified with the Global G.A.P. standard and 7 case studies were able to produce output certified with the G.A.P. standard namely Case study 2 Melon Farm, Case study 4 Guava Orchard, Case study 5 Mushroom Farm, Case study 6 Riceberry rice, Case study 7 Pomelo Orchard, Case study 8 Integrated Agricultural Garden, and Case study 10 Bangkachao Farm which constituted a very high standard of safe vegetables and the output was exported to Europe. Case study 3 Banana Orchard and Case study 9 Date Orchard were not yet certified with the G.A.P. standard. In the future, for the farmers who practice Smart Farming, if they want their output and goods to be recognized by customers and consumers, and with large sales, they need to be diligent and enthusiastic in having the production standard in compliance with the Good Agriculture Practices (G.A.P.) for plants fast.

4.6.10 Forming of Farmer Groups for Joint Farming

Smart Farmers who form the farmer group for joint farming in large plots all benefit from the joint activity in terms of production process with negotiating power for production costs and can negotiate the pricing of output better than sole practice with the nature of every man for himself which makes the agricultural sector faces problems and limitations affecting their income and livelihood with the problems of production costs such as costs of seeds, factors of production, agricultural machinery, agricultural labor force, as well as problems of the farmers' lack of negotiating power across the production process. Supply chain management and the problems of transfer of knowledge and technology have not really reached the farmers. Therefore,

to reduce such limitations, the government must promote farmers to form production groups with joint management. The forming of farmer groups for joint farming is one of the concepts of the new agricultural theory that His Majesty the Late King Bhumibol Adulyadej graciously bestowed as the practical guideline based on the conceptual framework of the Sufficiency Economy Philosophy. The development is identified in 3 processes namely Process 1) Initial new theory to solve the problems of farmers at the household level to have sufficient output for living all year round initially and sell the excess of output to earn income. When sufficiency and security at the basic level are fulfilled, then the farmers will enter the second process Process 2) Medium new theory which will form farmer groups in various models such as farmer group, cooperative, or enterprise to overall benefit the groups based on non-violence, sharing and mutual assistance according to one's ability. The successful forming of groups will lead to the third process Process 3) Advanced new theory by coordinating with other organizations at the national level such as banks, business companies to upgrade business and develop quality of life of farmers based on security and sustainability. In terms of the government support for agriculture in large plots, from the 10 case studies, it was found that there were 5 farmers who participated in the activity as follows: Case study 4 Guava Orchard was supported by Department of Agricultural Extension to set up a community enterprise at Ban Wang Nok Kai by forming the group of farmers who grew Gimju guava in community to strengthen the group and develop their sustainable quality of life, reduce expenses, increase revenue according to the Sufficiency Economy principle. Case study 6 Riceberry rice where the local farmer group was formed to jointly grow riceberry rice as organic farming with official from Rice Department as coach. The production of organic rice contributed to reduced production costs. Case study 7 Pomelo Orchard where the local farmer group was formed to grow pomelo with transfer of knowledge since the beginning with soil preparation, maintenance, use of fertilizer, pest control without the use of chemicals, maintenance of soil conditions and environment, as well as the use of fertilizer and pesticides. Case study 8 Integrated Agricultural Garden where local farmer group was formed for the joint cultivation of banana with required the cultivation period of 7-8 months. The cultivation started in May-June so that the yields would come out to coincide with the Chinese New Year in line with market

demand. Case study 9 Date Orchard where the local farmer group was formed for joint cultivation of date on the land of approximately 20 rai and the yields started to come out in the market. It was the investment that generated good income for the local farmer group. The economy of the participating household was better. The project to promote agriculture in large plots was a good project that would strengthen farmers. The key success factors of agriculture in large plots is the leadership who must be strong with vision, dedication, and for the common benefit of the group. Members must cooperate with the leader of the committee to drive the group's operation. Forming of groups or establishment of groups should come from the need of the farmers themselves and not forced upon them by the government agencies. The good government policy should be flexible in operation appropriate to the local context.

4.7 Recommendations on the Smart Farming Model

Based on the study of the model of Smart Farming in urban community, the analysis of the key success factors of Smart Farming, and recommendations of the model of sustainable Smart Farming for farmers in urban community through in-depth interviews with the entrepreneurs who practiced Smart Farming, experts, and relevant agencies, as well as fieldwork of 10 case studies of Smart Farming by using the conceptual framework of the model of Smart Farming, the study results revealed the summary and recommendations on the various issues as follows:

Input

Personnel

Farm owners and farm workers who practice Smart Farming in urban community all had good knowledge and understanding of the qualifications of Smart Farming, in terms of the knowledge of the current activity, information to accompany the decision-making on production and marketing systems, production and marketing management, awareness of product quality and consumer safety, CSR, as well as pride of being farmers at a very high level. The examples included the following: Case study 4 Suanpanisara “Happy to be a farmer that can deliver safe farm output to consumers.” and Case study 5 Mushroom Farm “Love and pride in farmer profession

to hand over to the family member of the next generation.” Therefore, Smart Farming should seek additional knowledge on advanced technology of Smart Farming to keep abreast with the ever-changing technology. Moreover, the government should organize online trainings to facilitate farmers who do not have to leave work by traveling to the training. The training course should consist of the topics of interest for farmers such as planning of production, planning of marketing and online marketing that benefit the practice of Smart Farming and should organize field trips and learn from successful farmers who practice Smart Farming to exchange opinions on the process of Smart Farming that will lead to success.

Budget

The farmers who practice Smart Farming in urban community mostly can manage expenses and necessities of budget in Smart Farming in urban community. They record information and statistics and prepare income-expenditure account and can systematically plan financial matters. So, they know the financial liquidity and the risk of current agricultural practice according to the cycle of output sold at the market whether profit or loss, major income and minor income. In the accounting process, the operation performance will be measured and summarized. After knowing the operation performance, the farmers can assess the status of budget planning in the future, how secure is the financial status or how possible to additionally invest in the future. The examples included the following: Case study 8 Integrated Agricultural Garden “Will live one’s life according to the Sufficiency Economy guideline namely 1. Moderation 2. Reasonableness 3. Self-immunity to ensure secure and happy family.” In terms of budget support from the government and relevant agencies for the farmers who practice Smart Farming in urban community, it is allocated to the farmers regularly every year from Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, including budget support to buy tools and equipment necessary to the profession and factors for the farmers who practice Smart Farming in urban community such as seeds, parent breeding stock such as duck, chicken, pig, and sheep for breeding, etc. Case study 10 Bangkachao Farm received budget from the government. “Very pleased to receive promotion and support from Department of Livestock Development who gives duck and chicken breeds for breeding experiment until become successful.” Therefore, for Smart Farming, in terms of income-

expenditure accounting and systematic financing, consideration should be taken of the necessity to additionally invest to procure factors of production in order to operate by themselves as appropriate to increase income instead of waiting for sole support from the government.

Tools and equipment

The tools and equipment for the operation of Smart Farming in urban community are sufficient for work as most farmers manage budget and plan production in advance through income-expenditure accounting. The necessary tools and equipment can be sufficiently bought. Case study 5 Mushroom Farm “There are sufficient tools and equipment for work. Some are invented.” and Case study 8 Integrated Agricultural Garden “The equipment that is necessary for work is complete without any shortage.” The farmers who practice Smart Farming in urban community all possess up-to-date information. The personnel have very good knowledge and understanding of the use of equipment. They have access to information sources for sufficient decision-making with the ability to use IT devices, Smart Phone, Personal Computer to seek additional agricultural knowledge, and attend trainings to acquire knowledge and advanced agricultural technology from government agencies. If it is necessary to procure additional tools and equipment in the future, the farmers practicing Smart Farming in urban community can also plan the budget for the procurement themselves. Therefore, in the future, if Smart Farming lack additional equipment necessary in the profession and need to procure it, the farmer group should be formed such as community enterprise or cooperative in order to present the project on the innovation of the new form of Smart Farming in order to seek support from National Innovation Agency, an agency under Ministry of Science and Technology, with management independent from the bureaucracy. It serves as a mechanism to support funding of innovation projects in the form of grants to develop model or pilot social innovation to solve problems in the Thai society in various dimensions. For example, upgrade the quality of life of community and environment leading to positive and sustainable change in society, promote social equality, and reduce social disparities with support not exceeding 1.5 million baht per project and with value not exceeding 75% of the value of the project seeking support to increase the efficiency of Smart Farming in order to succeed.

Acknowledgement of Smart Farming

The entrepreneurs who are farmers practicing Smart Farming in urban community know about smart farming from learning and practice in order to apply in their own farms. This is because the farmers all have access to advanced agricultural knowledge and technology which are beneficial to their profession. Moreover, the farmers know and regularly contact officials of Ministry of Agriculture and Cooperatives to inquire and discuss about additional agricultural knowledge and information for decision-making. They can also use IT devices, Smart Phone, Personal Computer to seek additional agricultural knowledge to benefit their own farm. Case study 2 Melon Farm “Officials regularly come to provide knowledge of the work of Agricultural Productivity Efficiency Increasing Learning Center.” Case study 6 Riceberry rice has the channel to know about Smart Farming from officials who regularly come to follow up on the work of the rice mill using solar energy. “Officials will come to follow up on the performance of the rice mill every month.” Therefore, apart from directly receiving information and news from officials of Department of Agricultural Extension, the farmers can also request additional information and news themselves from District and Provincial Agricultural Extension Offices. Moreover, the farmers can also receive knowledge on Smart Farming from online channels that they can search by themselves via Website, Facebook, Twitter, and Line chat program all the time. They regularly receive additional new knowledge to keep up with situations which enable their Smart Farming profession to be prosperous, progressive, and secure. They can efficiently plan operation to fulfill their targets.

Knowledge and understanding

The entrepreneurs who practice Smart Farming in urban community all have knowledge and understanding of the practice of Smart Farming in urban community and can efficiently transfer the knowledge to the interested public as they have clear knowledge of what they are doing. The entrepreneurs who practice Smart Farming in urban community can all be lecturers to transfer agricultural knowledge or give advice to the interested public. They are also invited to lecture in various forums and give advice to other farmers. They are able to be model farmers or point of learning to others. They have visitors to their farms for the study of plots. Some farms are

provided as learning centers under the projects of Ministry of Agriculture and Cooperatives or other agencies. However, there are still smart farmers who regularly need additional knowledge and understanding such as production planning, marketing and online marketing planning to benefit their profession. Case study 4 Suanpanisara: The owner joined training at Agricultural Productivity Efficiency Increasing Learning Center organized by Krathum Baen District Agricultural Extension Office. “I have received very good knowledge on the topic of interest which is the processing of Gimju guava from my farm to be able to increase value of output and hence more income.” Case study 5 Mushroom Farm: The owner participated in the training organized by Department of Agricultural Extension so that it was possible to process residue from spawn into fertilizer to grow lemons. “Instead of the residue that will be discarded as waste, with the knowledge from the training, I can process it into fertilizer to grow lemons and sell them to earn more income.” Therefore, in terms of Smart Farming practice, if the farmers think they still lack knowledge and understanding, they should add skills such as production planning corresponding to the market demand. They need to have more knowledge and understanding and diligence in seeking such knowledge to succeed in their Smart Farming profession.

Awareness of product quality

The standards of G.A.P./G.M.P., organic farming, safety standards of goods, or other standards are the issues that all entrepreneurs who are farmers practicing Smart Farming in urban community stress the extreme importance and attention. As Good Agriculture Practices (G.A.P.) constitute a type of agricultural production in the cultivation of plants, breeding livestock, and aquatic animals. Chemical pesticides, disease treatment, or chemical fertilizers, can be used but must have correct amount and in compliance with instructions After harvest, there must not be residual substance or at the level that causes danger to consumers. The standard not only benefits the entrepreneurs who are farmers practicing Smart Farming in urban community but also affects the health of customers and consumers, and sustainable environment. As for Organic Farming, it involves production in a farm without any use of synthetic chemicals such as insecticides, herbicides, vaccines, chemical fertilizers, and hormones in all production processes from cultivation till harvest. It also includes breeding of livestock taking account the environment, maintaining the

balance of the eco-system, at the same time, applying nature to increase output and develop disease resistance. The entrepreneurs who are farmers practicing Smart Farming were all interested in and aware of product quality and consumer safety as the first priority. Case study 6 Riceberry rice “The rice that is grown and consumed by oneself comes from the same rice fields. It is safe for both growers, customers, and consumers.” Case study 7 Pomelo Orchard “Apart from greatly reducing chemical costs, the organic farming also provides safety to the farm’s pomelo customers and consumers.” Therefore, Smart Farming practitioners must be aware of output quality and engage together in Smart Farming to regularly develop and improve the efficiency and the increased output with standard certified quality and safety, resulting in good health for customers and consumers for impression, confidence, and recognition, increase consumers’ satisfaction in terms of quality of output and goods from Smart Farmers who are major supporters of Smart Farming to ensure its survival from competition, sales of general agricultural output and goods. It is long-term success that leads to sustainable success of Smart Farming in the future.

Operational process

Planning

Process of Smart Farming in urban community starts with planning of production taking into account knowledge and ability of farmers practicing Smart Farming in urban community to see if the production of the goods will be successful or not, then proceeding to the next phase on market planning in parallel with production to ensure that the output is consistent with the demand of market and consumers. Entrepreneurs who are farmers practicing Smart Farming in urban community will plan production in response to the needs and production and market management. They will study the demands of the market before starting production to ensure that the output aligns with demand in the specific timing appropriate to market and consumers. Some farms need more clarity. There must be orders from the market first as a guarantee that when the output comes out, the products will all be sold and without residues that may cause damage or financial loss. Based on the study, Case study 1 Hydroponics Vegetable Farm would plan in advance prior to production. It would find customers who place their orders first before starting production. “We are confident that when the output comes out, there will certainly be

customers. And there is no problem with distribution.” Case study 3 Banana Orchard planned production in response to the customers’ demands. “Banana shoot culture according to customers’ orders ensure that our produce can certainly be sold.” Therefore, Smart Farming must focus on the importance of planning prior to production, know the marketing mechanism before production to know which product should be produced in response to market demand at appropriate and proper time to eliminate the problem of frantically find markets to support output without prior marketing planning which may face the problem of financial loss, as well as plan processing of output in case the sales do not meet the sales target, leading to oversupply in the market, and create diversity to output and goods that can increase value of the output, and accommodate transport.

Operation

Entrepreneurs who are farmers practicing Smart Farming in urban community follow the process of the operation appropriate to the environment of urban community while stressing the importance of safety standards and good quality of life. Some farms use clean energy in place of fossil-based fuel such as solar energy, and water management. Good and efficient water management requires clear management strategy to create sustainability. The responsible agencies at the national, the river basin, and the local levels are committed to solve major problems namely drought, floods, and water quality. The government agencies strive to solve the problems by formulating the policy on water management, the master plan on water management, restructuring of water management but the efforts have not met with sustainable success. Water management means any integrated action or actions relevant to water and other resources to solve the water problems, including water shortage, floods, and wastewater (Office of the National Water Resources, 2018), preservation of water sources in nature, management for optimum use. The process of Smart Farming is to use management technology to control, inspect, collect information, analyze, or solve agricultural problems by creating the system or utilization of devices to check light, humidity, temperature to facilitate, accommodate the farm work, and increase output without wasting time or money in the old agricultural practices. Up till now, the IoT (Internet of Thing) devices are applied in the agricultural sector such as the use of drone to survey the cultivated land, use of

automatic tractor to reduce workers' burden, use of high-precision devices, modification of fertilizer formula, amount of water used, lights received, as well as design automatic irrigation system, use of GPS technology to inspect the land conditions, climate, reduce risks from the outbreak of pests, natural disasters, temperature, light intensity, and other factors impacting growth, or smart greenhouse installed with the system to monitor climate change and control vapor spraying to reduce temperature. However, although at present more management technology is used for farming, one has to accept that in Thailand it is just the beginning of the R&D in applying technological devices to Smart Farming. Smart Farming requires development and support from many sectors, including the public and the private sectors, as well as the farmers themselves to need to learn to develop themselves and ready to change from the old methods of farming. The examples of the case studies are as followed. Case study 2 Lemon Farm: The owner undertook good waste management with budget support from Hydro-Informatics Institute (Public Organization) to conduct automatic farm control system by using IoT devices to warn from the smart phone screen regarding the information of water level, greenhouse temperature, and greenhouse humidity. "With good management, there is no more water problem. So, the farm has clean water all year round." Case study 10 Bangkachao Farm: The owner signed an MOU Project with PTT on Smart Farming with making fertilizer from waste. Moreover, many other agencies both public and private participated in activities with the farm such as Kasetsart University, National Research Council of Thailand, Central Department Store, M.K. Real Estate Development Public Company Limited, Suan Sampran "Both public and private agencies are interested in supporting us as they see that our farm has good management in terms of making fertilizer from waste." In order to drive Smart Farming to succeed, it is recommended that farmers develop their own potential to have access to and utilize agricultural technology and innovation, including knowledge on breed development, factors of production, including agricultural machinery and equipment, as well as capital to use in the profession, HR development in various agencies for readiness, coaches or trainers such as farmer friends who still lack knowledge. The private sector should also support the access to technology of production process, product processing, and increased value to agricultural goods

which will lead to income for smart farmers by changing the model of traditional management or enhancing on the Smart Farming in the future.

Follow-up and assessment

In terms of inspection and assessment of the Smart Farming practice in urban community, farmers should start by inspecting and assessing the operation whether it goes according to the plan or makes progress by considering the targets and objectives of the Smart Farming practice in urban community whether they are consistent with the performance and whether the operation meets with any problems and obstacles. The following examples of the entrepreneurs who are farmers practicing Smart Farming in urban community. Case study 1 Hydroponics Vegetable Farm: The owner started the practice of hydroponics vegetable farm with the objective of producing vegetables certified with the Global G.A.P. standard and exporting to Europe. The farm managed to fulfill the target and objective but met with the problem of not being able to export due to the spread of COVID-19 pandemic worldwide. Therefore, the guideline to solve the problem was to “Look for domestic market and assess if it is necessary to reduce or temporarily suspend production until the situation is better or returns to normalcy.” Case study 7 Pomelo Orchard: The great floods of 2011 damaged all the pomelo in the orchard. So, the owner had to start anew by using the guideline of Smart Farming for survival. “To use it as the guideline for self-development by applying the knowledge on Smart Farming to the pomelo orchard such as compilation of information of the weather, income-expenditure accounting to plan production in line with market and consumer demands, and close monitoring and assessment.” Therefore, farmers must conduct the ongoing evaluation to compare with the efficiency of the operation results last time. They must also conduct analysis of the findings and make recommendations of production operation to be used as the production guideline next time. The farmers must also make assessment by comparing before and after production with expectations whether the expectations meet with the objectives. The performance must also be summarized whether the production meets with success or failure which will benefit learning. Smart Farming practitioners should monitor and assess the overall effectiveness of the following: 1) Assess the efficiency and effectiveness in operation, success in fulfilling the target of the action plan 2) Cost-effective operation measuring from economic value,

calculated from expenditure of the production and the output quantity of the project, and improvement of production under the Smart Farming guideline to accomplish the targets and objectives more in the future.

Development and improvement

Smart Farming that ensures success in the profession requires planning of operation. The action plan must be practical and systematic in terms of processes, skills, tools, and technology. If there is any problem or obstacle at work, it can be inspected, rectified, improved, or developed so that the operation can succeed and the performance fulfills effectiveness and efficiency. The study findings of the Smart Farming in urban community revealed that there was development and improvement in the following case studies. Case study 2 Melon Farm was a Smart Farm with the closed system. In the past, the farm met with the problems of production process. So, the owner had to totally rethink and redo as the cultivation of melon and salad in the greenhouse was different from the outdoor cultivation. He used the IoT (Internet of Thing) devices to support the automatic farm control system by controlling temperature, humidity in the air and the soil, spraying of water, fog, drug for the melon and the salads. The performance met with success with continuous inspection and development. "There was development and improvement especially for soil and fertilizer formulas. I continued to study by myself until I acquired my own formulas. When everything was in order, in 2015, I resigned from my job to become a full-time farmer." Case study 7 Pomelo Orchard: Due to the great floods in 2011, after the floods, all fruits in the orchard died and the owner had to start anew. Therefore, he had to plan the operation again by applying the concept of Smart Farming as a farming guideline as well as self-development to apply the knowledge of Smart Farming in the pomelo orchard such as compilation of weather information, income-expenditure accounting to plan production in line with the market and consumer demands. Moreover, performance was inspected in terms of output and operational costs. "There is continuous development and improvement to increase output, reduce the use of chemicals, and use biofertilizer in the orchard for the safety of farmers and consumers." . Therefore, Smart Farming should focus on planning of operation by selecting feasible plans for operation to ensure success. The development and the improvement of Smart Farming aim to ensure that farmers are prepared in terms of

knowledge and expertise in practicing farming profession across the value chain of the agricultural production in line with the lifestyle and establishment features of each individual. It also focuses on the use of knowledge and information to accompany decision-making, the use of technology of wisdom knowledge and best practice to be used or developed recognizing quality, standard, and amount of market demand, as well as consumer safety, and environment.

Output

Income

The income from Smart Farming practice in urban community of the entrepreneurs who are farmers with such practice has higher return. Because prior to operation, the farmers will consider if it is possible to produce, fulfill the targets, and succeed as planned. The production process is planned with caution with the use of technology to control production to ensure output with standard quality and reduced loss. Marketing is also planned in order to produce goods in response to the demand of market, customers, and consumers at the most appropriate time. The output also has standard and good quality and can be sold according to the target. As a result, the entrepreneurs who are farmers practicing Smart Farming in urban community receive good return on investment and earn income according to the target. The case studies are as follows: Case study 6 Riceberry rice “I am happy with the revenue from many sources both from the farm and milling fees from the rice mill.” Case study 9 Date Orchard “In terms of income, when the tree reaches 5 years old, it will yield approximately 100 kg./tree. The current buying price at the farm gate is approximately 200 baht/kg. and the income is approximately 20,000 baht/tree/year. I am happy with the income from the farm output.” Smart Farming ensures more efficient production process with the continuous compilation of information and the Zero Waste management. So, the smart farmers can calculate the cultivation land, various genetic models with good quality in line with the demand of consumers in various types or as customization in order to sell the output and goods at the appropriate prices without oversupply and easy selling. At present, Smart Farming can gain access to easy selling through the online market in various applications through the support from the public and private sectors. Thus, Smart Farming must place importance on production process to ensure that the output has standard and

good quality, as well as marketing planning, and knowledge on market mechanism and online marketing to ensure that the quantity of the output and goods is completely sold out without causing damage which will enable the Smart Farming to earn more from output.

Output

In terms of output from Smart Farming in urban community of the entrepreneurs who are farmers practicing Smart Farming in urban community, the output is high. Because for Smart Farming, the information is recorded as the statistics that will be used to analyze for decision-making on production planning. Moreover, the IT devices are used for production planning such as the use of smart phone and personal computer to search for additional information, knowledge, advanced technology for the profession and the use of the IoT (Internet of Thing) system to increase efficient work and reduce costs in the farms. Case study 5 Mushroom Farm: Income derived from many channels, including sales of mushroom, spawn, fertilizer from spawn, and processed products. “For the mushroom output, market vendors will come to fetch for sales of which the farm will charge 60 baht/kg. and the vendors will sell it at 80 – 100 baht/kg.” Case study 9 Date Orchard “I am satisfied with income. When the tree reaches 5 years of age, it will yield approximately 100 kg/tree. The current buying prices at the farm gate is approximately 200 baht/kg. The income is approximately 20,000 baht /tree/ year.” Therefore, Smart Farming should develop the production process with quality, standard, and safety in production process that can make differentiations of the goods and output from Smart Farming with other agricultural products. In terms of quality, standard, and prices, and cost advantage, if Smart Farming business can offer the goods and output with good quality but lower prices, it will be very competitive compared with other agricultural goods. The output from Smart Farming is higher than the output from general farming in terms of efficient production, reduced use of labor force as some work will require the introduction of technology which will reduce the labor costs. The output and goods will be of higher quality due to the introduction of precision tools and due to breed improvement, modification of fertilizer ratio, watering, and lighting, etc. Although the investment in technology is

higher, it is a one-time investment that lasts a long time. As a consequence, Smart Farming receives return in the form of higher output with better quality.

Impact

CSR

The systematic CSR for the practice of Smart Farming in urban community and the care for the social and environmental quality of the entrepreneurs who are farmers practicing Smart Farming in urban community is important and attracts great interest. The farmers focus on production process that does not generate pollution and does not destroy the environment (Green Economy). They omit burning the rice stubble or residues from agricultural production, use bio fertilizer, reduce the use of chemical fertilizer, use bio technology to manage pests, and reduce the use of chemicals in pesticides. The entrepreneurs who are farmers practicing Smart Farming in urban community also conduct continuous CSR activities. Case study 6 Riceberry rice: The owner thought that what one took from nature, one must give it back. “The example of riceberry rice is not burning, not taking anything out. After harvest, the rice stubble will not be burned but left in the fields to be degraded into fertilizer while waiting for the next cycle of rice cultivation.” Case study 7 Pomelo Orchard “I place importance on pesticides by using microbial pesticide from microorganism such as mold, bacteria, and virus as an alternative to efficiently and environmental-friendly reduce or replace the use of agricultural chemicals.” Therefore, Smart Farming should support sustainable production process by focusing on production of quality products and least environmental impact especially efficient resource management. That is, the optimal use of raw materials to reduce waste, as well as find the guideline to process waste for reuse in accordance with the concept of sustainable development and CSR activities of the farms under the concept of ethics and good management both in and outside the farms such as the following case study. Case study 5 Mushroom Farm: Use of saw dust from rubber wood processing. With the expiration of the spawn, it would be used to be processed into fertilizer to grow lemons, leading to sustainable development, especially for the surrounding society expected to receive care and attention from Smart Farming practitioners. As social citizens, one of the duties of Smart Farming practitioners is to implement to acquire the rights to exploit resources available in the society.

Sustainability

Entrepreneurs who are farmers practicing Smart Farming in urban community undertake environmental management for systematic Smart Farming in urban community without destruction but creation of balance of the cycle of people, economy, society, resources, and environment such as from the following studies:

Case study 6 Riceberry rice: The entrepreneur who was farmer practicing Smart Farming in urban community practiced riceberry rice cultivation. “Without burning rice straw, without taking anything out.” After harvest, rice stubble will be left in the field and degrade into fertilizer while waiting for the next cycle of rice cultivation. The rice stubble will then degrade into organic fertilizer.” It can reduce chemical fertilizer which will cause the balance of the cycle of people, natural resources, and environment as sustainable Smart Farming in urban community perfectly and usefully.

Case study 7 Pomelo Orchard had good knowledge on organic farming. The concept of organic farming was “Do not use chemicals to maintain soil conditions and environment as well as maintain health of himself and consumers with production process that is in line with the standard of organic farming for sustainability.” Moreover, Smart Farming promotes sustainability by using packaging that extends shelf life and is environmental-friendly. It is important for agricultural goods. As Thailand is a tropical country, the output wrapped in thin cover may degrade easily. It is necessary to choose the packaging to preserve output for a long time, as well as monitor and inspect output quality with speed, precision, without destroying output. The technology of container is used to control ozone atmosphere that can control fruit skins, control the use of coating to extend the shelf lie and preserve the quality of agricultural output, as well as processing of agricultural raw materials, or agricultural waste with the process of bio technology using microorganism, bacteria, yeast, enzyme, or others which act as a factory resulting in the bio-based products with higher value added, including fuel, energy, biochemicals, animal feed for the future, food for the future, biopharmaceuticals, and products to control pests with biotechnology. Therefore, the requirements of the 6 qualifications of Smart Farming can recommend the methods towards sustainability as follows:

1. Smart Farming has knowledge in what one is doing and can serve as lecturer to transfer knowledge to others, and can be model farmer or point of learning to others
- 2.

Smart Farming has information to assist in decision-making, can get access to information on sustainability, from officials, IT technology system, and other communication channels. There is recording of information and use of the information to analyze the planning before operation and sustainable output management in accordance with the market demand. The information is used to solve problems and develop one's own profession 3. Smart Farming has the ability of production and marketing management by managing factors of production, labor force, and capital in accordance with and connection of production and marketing to sell output, as well as efficient management of waste from production (Zero Waste) 4. Smart Farming is aware of product quality and consumer safety by being experts or attending trainings on the standards of G.A.P., G.M.P., organic farming, or other standards and with the production process consistent with G.A.P., G.M.P., organic farming, or other standards 5. Smart Farming is responsible for the environment and society with the production process that does not generate pollution and does not destroy the environment (Green Economy), and with continuous CSR activities 6. Smart Farming is committed to the farmer profession, with love and cherishment of land and the profession for the next generation, and happiness and satisfaction in the profession.

Environment

In case of the impact on the eco-system, air, water, noise, and waste from Smart Farming in urban community, entrepreneurs who are farmers practicing Smart Farming in urban community have knowledge and understanding of the impact of environment on urban community. Because prior to practicing Smart Farming in urban community, there have been planning and study of the impact on the eco-system, air, water, noise, waste. The most important principle is the importance of environment. Production process must not generate pollution and must not destroy the environment (Green Economy). Focus should be on bio fertilizer and reduced use of chemicals. Bio technology is used to manage pests. Entrepreneurs who are farmers practicing Smart Farming in urban community should have Zero waste management by using the principle of reduced amount of waste as much as possible or no waste. The key is to discard waste since origin by focusing on the reduced use of excessive resources, reuse, sorting for reuse before it will become waste for

disposal. This is to maximize the benefit of this residue or waste. Examples of the study results are as follows: Case study 6 Riceberry rice uses the guideline to practice organic farming without the use of chemicals. Two varieties of rice for organic farming include Riceberry rice and Thai Phathumthani Fragrant Rice 1. They meet the 9 criteria for the practice of organic rice and they are certified with the standard of organic rice production system from Rice Department “The scope can certify the 3 scopes namely production source of organic rice, processing of organic rice, and packaging of organic rice to produce and process organic rice for delivery to consumers with official from Rice Department as coach” and Case study 7 Pomelo Orchard placed importance on elimination of pests with microbial pesticide from microorganism such as mold, bacteria, and virus which was an alternative to reduce or replace agricultural chemicals that was efficient and environmental-friendly, without toxic substance or chemical residue and avoid chemical contamination in the soil, water, and air for biodiversity in the eco-system and rehabilitate the environment according to the natural balance as much as possible without using artificial chemicals or GMO. “The government sector plays a role in driving and supporting the use of microbial pesticide to eliminate pests as the guideline to develop the country’s agriculture for safety and sustainability.” Therefore, Smart Farming should focus on environmental care and protection as environment is a very complicated system. Smart Farming can contribute to environmental protection and reduce of impact. It can control the efficient land use, reduce the degradation problem of the soil conditions and water causing the wastewater problem, reduce excessive use of water, fertilizer, chemical pesticide that control the use in accordance with the need with IoT (Internet of Thing) devices to reduce burning to get rid of agricultural materials and change to processing as bio fertilizer such as cob, rice stubble, etc.

Quality of life

The farmers practicing Smart Farming can be said that smart farmers have good quality of life with skills that plan operation in each process from production, marketing planning, online marketing, to distribution to consumers. The products from Smart Farming can be sold and meet the target with quality, standard, and safety without any products left to cause loss. Therefore, smart farmers have secure income and can provide for the 4 requisites namely food, housing, clothing, and medicine. As

a result, Smart Farming contributes to good quality of life. That is, people who can live their lives appropriately with society without burden or social problems. It is a complete life both physical and mental. They live their lives with righteousness in line with environment, attitude of the society that can solve problems and correctly seek the things that they desire under the available tools and resources. Case study 2 Melon Farm: The owner was diligent in seeking additional knowledge by participating in trainings organized by government agencies. He was also supported to develop the management system within the farm based on standard and correctness. “I can succeed in farming profession that meets my wishes resulting in better quality of life.” Case study 4 Suanpanisara. At present, in 2022, it has been 5 years that the dates were first grown and output has come out for sales. The farm started to receive tourists as agro-tourism. “So, the overall income for farming profession is over 30,000 baht a month. I am proud to be a farmer with good quality of life.” Therefore, Smart Farming should find additional knowledge to ensure that Smart Farming can produce output according to the goal of Smart Farming and should place importance on knowledge and good understanding on Smart Farming. There is also planning on production, marketing, and online marketing. Smart farming is practiced with quality, standards, safety, and its output can be completely sold to consumers. If the products are left from the sales, preparation must be planned to process the goods and increase value of the goods in order to ensure that Smart Farming generates good income from the sales of output and goods that will take care of household members to have the 4 requisites and to ensure that all family members have good quality of life and sustainable happiness. Moreover, Smart Farming should undertake Good Agriculture Practices (G.A.P.). It means agricultural production that can use chemicals to get rid of pests, serve as medicine, and use chemical fertilizer in production but the quantity must be correct and follows the advice. After harvest, there will be no residue or at the level that will be harmful to consumers. It benefits entrepreneurs who are farmers practicing Smart Farming in urban community to have good quality of life and result in good health for customers and consumers, and sustainable environment.

Circular Economy

Smart Farming in urban community is farming that basically generates the circular economy in the community that entrepreneurs who are farmers and practice

Smart Farming in urban community adhere to as practice with planning and design of the use of limited natural resources for efficient use, maintain and create optimum value of the resources in the system through the use of materials and products as long as possible, reduce emission of carbon dioxide, until it results in the circular cycle of resources continuously in the closed system without transporting waste outside the system, resulting in balance between humankind and natural resources to solve the problems of the excessive use of resources from the expansion of the global population, leading to the drive towards sustainable economic system in the end. For example, duck and chicken breeding, use of duck and chicken droppings, use of food waste from households, or agricultural waste used as fertilizer constitute the circular activity to be utilized in the farm to reduce costs and rely on oneself. The agricultural activities that are consistent with Thailand's BCG Economic Model through the reprocess and reuse of used resources. For example, Case study 5 Mushroom Farm: "The expired spawn is used as fertilizer and for the cultivation of lemons which can be sold and contribute to reduced waste." Case study 6 Riceberry Rice Farm: "There is no burning of rice straw without taking anything out. After harvest, rice stubble will be left in the field without burning and degrade into fertilizer while waiting for rice cultivation in the next cycle." It is the method that stresses the optimum use of resources to solve excessive exploitation of the resources. Smart Farming in urban community truly generates the Circular Economy. Therefore, Smart Farming must realize the value of surrounding objects, including household waste or agricultural residues. It must also focus on the operation based on the Circular Economy which is the system developed to solve the problems of waste and natural resources by optimizing products, components, and materials with appropriate methods such as reuse, repair, reproduction, as well as development of business model, innovation, and monitoring to manage products and circular materials within the system to reduce waste and produce more by reducing the use of resources and energy which will positively impact Smart Farming to ensure more efficient resource management. The decreased amount of waste in the system, reduced greenhouse gas emission from production process and Smart Farming can reduce costs and increase income of Smart Farming, increased competitiveness compared to general farming, as well as creativity and innovation of Smart Farming.

4.8 Recommendations from the Farmers on The Model of Smart Farming

Based on the presentation of the model of sustainable Smart Farming for farmers in urban community through the online meeting with the Smart Farming entrepreneurs of the 10 case studies using the conceptual framework of the prototype Smart Farming. The summary and recommendations are as follows:

Input

In terms of personnel, the researcher recommended the following, “Smart Farming entrepreneurs should seek additional knowledge on advanced technology for the practice of Smart Farming in order to keep abreast with changes. The government should also arrange for study tours of successful Smart Farming entrepreneurs and online meetings. As for the online meeting, some Smart Farming practitioners recommended the following, “It may not be appropriate in terms of acknowledgement and understanding of the content of Smart Farming. Consideration should be taken of the appropriateness of the content of the meeting and the method of presentation. For example, for workshop or demonstration of some agricultural practices, Smart Farming practitioners need to see and touch by themselves in real life which will create knowledge and understanding better than online training and meeting.” In terms of the budget, there was recommendation that Smart Farming practitioners “should consider the necessity of additional investment to increase income.” But a Smart Farming practitioner put forward the following recommendation “I would like the government to support the operation of Smart Farming by allocation long-term continuous budget. Up till now, the budget is determined for a short period of time. Trainings have been held to transfer knowledge to Smart Farming practitioners. But with the new fiscal year, the trainings are suspended due to the lack of supporting budget so there is discontinuity of the meetings. It may result in Smart Farming’s lack of cooperation to attend trainings in order to acquire additional knowledge from government officials in the future.” If it is necessary to buy additional tools and equipment in the future, it was recommended that Smart Farming entrepreneurs “should group themselves in the form of cooperative or community enterprise to present the new model of Smart Farming project to seek funding from National

Innovation Agency.” But some Smart Farming entrepreneurs “are supported by National Research Council of Thailand for the new agricultural practice using high precision technology to increase output with optimal resource utilization in view of the development of Thailand’s sustainable agricultural sector and promotion of innovations which are necessary for the learning of Smart Farmers to ensure appropriate application in each area.” In terms of acknowledgement of Smart Farming, it was recommended, “in terms of acknowledgement channels, apart from the information at District and Provincial Agricultural Extension Offices, there are online channels that the Smart Farming practitioners can seek additional knowledge by themselves all the time.” Based on experiences, a farmer said, “I think responsible agencies such as District Agricultural Extension Office or Provincial Agricultural Extension Office should have clear project action plan. Often, there are only plans but no operation of concrete projects. The policy runs in the opposite direction with the implementation so that Smart Farming practitioners face the problems of communication to receive additional knowledge in particular topic. There is only chart and no real implementation which causes damage to the Smart Farming practitioners who are determined to practice this profession.” In terms of knowledge and understanding, it is recommended, “In practicing Smart Farming, if the Smart Farmer views that he/she lacks any knowledge, additional knowledge should be speedily sought.” A Smart Farming entrepreneur recommended the following “There should be exchange, learning, and experience of knowledge among Smart Farmers in the adjacent areas. If a Smart Farming entrepreneur succeeds in profession and acknowledge, it should receive cooperation from the public and the private sectors in sharing knowledge and experience to farmer friends and those interested continuously and regularly for the general benefit and progress in Smart Farming.” In terms of awareness of quality product, the recommendations were as follows, “Smart Farming must be aware of the quality of output, goods, and must cooperate to practice Smart Farming in view of development and improvement for higher efficiency and output, quality, standard, and safety.” On this issue, a Smart Farming entrepreneur made the following recommendation, “There is still concern about the danger from chemicals that Smart Farming practitioners must still use according to the standards of GAP or Organics Thailand. They want the government agencies to conduct strict inspection

as at present only 6 chemicals were inspected for safety standards. Up till now, the government sector bans the import of some chemicals but the names of the chemicals are changed and they are imported as before. Smart Farming practitioners themselves must seek knowledge on microbial pesticides to replace the chemicals that are banned from import. The government sector should concretely formulate the policy to promote and support this matter for the safety of farmers and consumers.”

Operations

In terms of planning process, there is recommendation to the Smart Farming practitioners as follows, “Importance must be placed on planning before production and marketing mechanism before production to know what products to be produced in response to the demand of the market at the appropriate and correct time to eliminate the problem of frantically searching for markets for the output. Without marketing planning, the farmers may meet with loss. The processing of goods must also be planned in case the sales do not meet the target.” A Smart Farming practitioner made the additional recommendation, “The production must be planned to be consistent with the seasons and the demands of market, customers, and consumers. The period when there a lot of pests must be avoided as they can damage the output. The support must be planned in case there is demand of the consumers during the period when there is the problem of pests and to go ahead with the production process to avoid the damage.” In terms of operation, the researcher made additional recommendation, “Smart Farming practitioners must develop their own potential to gain access and make use of agricultural technology and innovation in terms of knowledge, breed development, factors of production, agricultural machine and equipment, as well as capital to use in the profession, personnel development in the organization to be ready to serve as trainer for farmer friends who lack knowledge. The private sector should support the access to technology, production process, product processing, and increased value of agricultural goods.” A Smart Farming practitioner made additional recommendation, “The farmer should select the technology that suits the environment in the Smart Farming practice for the maximum benefit that is not excessive and for the fullest efficiency, without burden of costs for operation, increased work efficiency, and increased output and income for Smart Farming practitioners.” In terms of monitoring and assessment of the recommendations from the researcher,

“Smart Farming should monitor and assess the overall effectiveness namely 1. Assess the efficiency and effectiveness of operation and success to fulfill the objective or target of the action plan 2. Cost-effective operation measured by economic value, calculated expenditure in production and amount of output in a project, improvement of production according to the guideline of Smart Farming to increasingly reach the targets and objectives in the future.” A Smart Farming entrepreneur made additional recommendation, “Smart Farming requires long-term consideration on appropriateness in the calculation of break even point and not short-term consideration. Sometimes, the cost-effective calculation requires consideration from many aspects of surrounding environment such as production process, marketing, and competitors in relatively competitive environment to use the followed information in the assessment and consideration of the potential and ability to operate in various aspects in order to improve Smart Farming for higher success in the future.” In terms of development and improvement, recommendation for Smart Farmers was put forward, “Importance should be placed on operation planning by considering the plan that is feasible for operation because it will impact success. The goal of the development and improvement of Smart Farming is to equip farmers with readiness in terms of knowledge and expertise in the agricultural profession in the value chain of agricultural production in line with the lifestyle and nature of operation of each individual farmer.” Recommendation from a Smart Farming entrepreneur as followed, “Smart Farming requires development and improvement that usually start with solving problems through consideration of problems from various forms of operation, urgent problems requiring prioritized solutions, and then solving the problems in a rectification process step by step and in a systematic manner such as recording and learning of various processes to be used as a norm to develop and improve operation according to the concept of Smart Farming to meet with success.”

Output

In terms of income, the researcher made the following recommendation, “The Smart Farming practitioners must stress production process to ensure output with standard and good quality, as well as marketing planning and knowledge on market mechanism and online marketing so that the output can be sold according to the produced amount without unsold output that can cause damage. It will enable the

Smart Farming entrepreneurs to earn more income.” A Smart Farming practitioner commented, “I agree with the importance placed on marketing and online marketing planning as it is more cost-effective investment than investment in offline market which costs more. There must be development of the product quality from Smart Farming with production process based on standard, and quality in parallel with safety to ensure the confidence of customers and consumers and success in sustainable income.” In terms of output, the researcher made the following recommendation, “The Smart Farming practitioners should develop production process for output with quality, standard, and safety in production process to differentiate between the goods and output from Smart Farming and general agricultural goods in terms of quality, standard, and prices.” A Smart Farming practitioner agreed with the recommendation and added, “Technology should be used to increase output as at present the labor costs in the production of goods from Smart Farming are very high. The cost for unskilled worker starts at 400 baht so farmers have to bear a lot of burden in terms of costs. If they use technology to increase output, they are still concerned about initial investment and they do not know if the system can increase benefit from the old agricultural practice.”

Impact

In terms of CSR, the researcher recommended the following, “Smart Farming should support sustainable production process, focus on production of quality products with least environmental impact, especially efficient resource management which is optimal raw material utilization, as well as guideline to process and reuse waste in line with the concept of sustainable development, CSR, ethical operation, and good management both in and outside the farm.” A Smart Farming practitioner provided additional recommendation, “Up till now, Thailand practiced monoculture which seriously destroyed the environment. So, it should switch to integrated farming. The production process of Smart Farming requires environmental-friendly agricultural practice, reduced use of chemicals or chemical use in compliance with safety standards determined with caution, without danger to growers, customers or consumers.” On sustainability, the researcher made the recommendation, “Smart Farming can promote sustainability by choosing packaging which is environmental-friendly and with long shelf life. It is important for agricultural practice as Thailand is a tropical country, the

output wrapped in thin cover can rot easily. So, the packaging must be selected to keep the output for a long time, also with monitoring and inspection of quality output with speed, accuracy, without output damage. To this end, technology should be selected for container that can control atmospheric ozone that can control fruit skins, control fruit coating to lengthen the life and maintain the quality of agricultural output, process agricultural raw materials or agricultural waste based on bio technology with the use of microorganism.” A Smart Farming entrepreneur made additional recommendation, “Use of technology which is appropriate to Smart Farming practice of farmers. The farmers must have knowledge and ability to develop and improve technology that is appropriate to work and enhance on his or her work or cooperative member friends to succeed, and not usage which is not appropriate to the work. It will not worth the usage and the costs in practicing Smart Farming.” In terms of environment, the researcher made the following recommendation, “Smart Farming should focus on environmental preservation and protection as environment is a very complicated system. The concept of Smart Farming will preserve the environment and reduce impact. Smart Farming can efficiently control land use, reduce land degradation, and wastewater pollution, reduced excessive consumption of water, fertilizer, chemical pesticides.” A Smart Farming practitioner made recommendation on the environment, “Smart Farming must adapt itself more in terms of climate change and pests which evolve more than in the past, and residual chemicals. Smart Farming must take into account its own environment whether the adjacent area uses a lot of chemicals or not. The buffer area must be designed to prevent the chemicals to disturb or contaminate their output. The farmers must adapt themselves to the environment in each area and create good environment in their own plots. There must be water storage to prevent contamination of water from adjacent plots with chemicals and the management of the optimal usage of output from the plots such as the use of microbial pesticide to replace chemicals.” In terms of quality of life, the researcher made the following recommendation, “Smart Farming practitioners should seek additional knowledge to ensure that Smart Farming can produce output that meets the target of Smart Farming and should place importance on good knowledge and understanding of the acknowledgement of Smart Farming, production planning, marketing planning, and marketing planning to practice Smart Farming with quality, standard, safety, and can sell products to consumers in full

amount. In case of residual goods from sales, preparation should be planned to process the output and increase value to agricultural goods from Smart Farming. This is to ensure that Smart Farming practitioners can earn high income from the sales of output and goods which will lead to the ability to take care of all household members to have complete possession of the 4 requisites. It is to ensure that all family members of Smart Farming have good quality of life and sustainable happiness. Moreover, Smart Farming practitioners should practice Good Agriculture Practices (GAP).” A Smart Farming practitioner made additional recommendation, “The ability in the production process of a farmer in general is to produce approximately 1-3 types. Initially I want sharing, exchange, or buy a particular output from other farmers in the adjacent area first to get safe output and goods with quality and cheap prices to have good health and maintain good relationship with neighbors and as good group members, leading to close connection and reduced costs of living through mutual assistance. Smart Farming members will have relationship and assistance that is good to the quality of life of all Smart Farming members. No one will lose but everyone will reap benefit and will win. The output is shared and distributed and we gain friendship and good health.” In terms of the Circular Economy, the researcher made the following recommendation, “Smart Farming practitioners must realize and know the value of things around them, whether household waste or agricultural material scraps. They must focus on the operation based on the Circular Economy which is a system that is developed to solve the problems of waste and natural resources by utilizing products, components, and materials as much as possible with appropriate methods such as reuse, repair, re-production, development of business model and innovation, and follow-up to manage products and materials to ensure that they will circulate within the system, reduced waste, increased production, and reduced consumption of resources and energy. ” A Smart Farming practitioner made additional recommendation, “Each Smart Farming practitioner has his or her own technique and method to create the Circular Economy that is different. If the farmers form a group and cooperate for good environmental management, linkage, and sharing to jointly construct the model of the Circular Economy, it will increase the size of the economy or may overlap in many layers. It is similar to agriculture in big plot but this model is a big plot of environment. Moreover, each farmer can collect the information on environmental management in his or her

own farm and proceed with carbon credit such as reduced consumption of energy in the farm, waste management in the farm, Zero Waste, and plantation of big trees in the farm to reduce the amount of carbon in the farm, etc. If Smart Farming practitioners collect this information together, they can register for environmental management and in the future they can show the ability to reduce the fee on greenhouse gas. The overall environmental preservation will be a bigger system. The government should place importance on the information survey for certified registration to reduce costs which at present are as high as 100,000-150,000 baht/person which will make the Circular Business take place easier instead of focusing and supporting only reforestation without focusing on the minor unit of Smart Farming with the ability to reduce greenhouse gas such as the reduced use of chemicals by replacing with compost that can better preserve the environment in the system.”

4.9 Appropriate Model for Smart Faming

Starting from the extraction of factors and proposing a sustainable model of being Smart Farming in urban communities. By using the conceptual framework of CIPPI Model as an assessment to consider Feasibility, suitability and sufficiency of resources to be used in smart agriculture, such as budget, personnel, materials, time. including technology and operational plans, etc. through online meetings (online) of entrepreneurs who are Smart Farming

10 case studies have provided recommendations on the appropriate model for smart farming (Smart Farming). as in Figure 4.33



Figure 4.33 Appropriate Model of Smart Farming

CHAPTER 5

CONCLUSION, DISCUSSION, AND RECOMMENDATIONS

Smart Farming in Urban Community

The model of Smart Farming which constituted sustainable agriculture in urban community aimed to study Smart Farming in urban community as well as problems and constraints, analyze the success factors of Smart Farming urban community, recommend the model of Smart Farming which constituted sustainable agriculture in urban community, select the farm that met the criteria of the prototype farm of Smart Farming with 10 case studies, and interviews with the key informants namely entrepreneurs, Smart Farming practitioners on their operations, lessons learned, key success factors, problems and constraints, and analysis that drove Smart Farming, experts, and relevant agencies, as well as field trips of 10 Smart Farming case studies to present the model of Smart Farming, and use the model of Smart Farming recommended through online meeting to serve as the appropriate model of Smart Farming in urban community.

5.1 Smart Farming in Urban Community

5.1.1 Smart Farming

For the agricultural practice of Smart Farming in urban community, most farmers started from the traditional method of agriculture handed down by their ancestors. The production process relied on the richness of the climate. The output did not meet the standards and safety due to its dependence on chemicals. During the cultivation phase, fertilizer must be used. Prior to harvest, pesticides were sprayed to ensure that the output met the target which would easily harm the health of growers, customers, and consumers. Most farmers were committed to succeed in agricultural profession by seeking new and additional knowledge and technology on agriculture

from trainings held by the public and the private sector. In terms of the 10 case studies, it was found the following:

Case study 1 Hydroponics Vegetable Farm started from the interest to practice agriculture as a profession without any prior knowledge or experience. The farm owner was determined to succeed in the profession. Prior to farming operation, the farm owner had to seek information, knowledge, and technology on agriculture by attending the training held by Department of Horticulture, Faculty of Agriculture, Kamphaeng Saen Campus, Kasetsart University. After the farm owner was confident with the knowledge and experience from the training, prior to production process, he sought market to support the output to ensure that the market could absorb the output 100% without worries. The output was completely sold. Finally, when the order was surely received, then the production process would start. Case study 2 Melon Farm where the farm owner's parents were farmers. The owner graduated with a B.A. Degree and worked in a company. But due to his love and interest for the farmer profession, in the beginning, the owner divided his time by experimenting on melon cultivation during the weekend until he was sure that the output and marketing were good and then he resigned from his regular job to practice farming full time. In the beginning, he met with a lot of problems due to pests and operation of greenhouse covered by mosquito nest. But he overcame the obstacles and met with success. Case study 3 Suanlungthod where the owner graduated with an M.A. Degree. Being the only child and having to work far from home, the owner was concerned about his parents who lived by themselves as fruit growers at old age. He decided to resign from work to practice agriculture by cultivating banana shoots using local wisdom handed down by his parents. He started online marketing which was sold as planned. Case study 4 Suanpanisara where the owner graduated with B.A. Degree and worked in Bangkok. But being concerned about her parents who lived by themselves as fruit growers, the owner decided to resign from work to look after them. She started by continuing the farmer profession by cultivating guavas, rose apples, and dates. The output was satisfactory. The farm mainly used compost for consumer safety and formed a group of local farmers as community enterprise to jointly cultivate guavas in big plots with great success. Case study 5 Mushroom Farm where the owner was engineer by profession in a company before embarking on the farming profession. He

thought it was an independent profession and could develop himself for progress and security than the present job. He started from travelling to attend the training on mushroom culture at Faculty of Agriculture, Chiang Mai University. He experimented on the culture and sought knowledge by himself for 5 years. With trial and error, he reaped experience by himself. He never gave up for any problems. He was able to invent materials and equipment appropriate to mushroom cultivation by himself until he was successful in obtaining the output with quality and standards. Moreover, he could produce spawn for the interested farmers to grow and sell them for additional income apart from the sales of the farm mushroom.

Case study 6 Riceberry rice with paddy-sown field for Pathumthani Fragrant Rice jointly with the investor who invested and brought in seeds. When the investor suspended operation, the farm owner turned to cultivation of riceberry rice. At first, he experimented and learned by himself until he received support from District Agricultural Extension Office and Provincial Energy Office- Nakhon Pathom to support rice mill run by solar energy. He managed to market by himself. Moreover, he planted additional fruits such as aromatic coconut and guava to increase family income. Case study 7 Pomelo Orchard where the family fruit orchard was completely destroyed after the great floods of 2011. So, the owner decided to resign from his regular work in Bangkok to care for the orchard of his parents in their old age. He had to start everything anew from soil preparation to selection of fruit varieties for cultivation in the farm. Apart from Citrus Maxima (Burm.f.) selected for cultivation, additional lemon and betel palm were grown in an integrated manner. It was practice of organic farming without the use of chemical which was safe for farmers themselves, customers, and consumers. Case study 8 Integrated Agricultural Garden where the owner started the farmer profession since 7th grade until the present time. His output helped earn good income for his family such as Cavendish banana, and palmyra palm. He was a model farmer who lived his life according to the Sufficiency Economy. The owner made recording, and income-expenditure accounting. He was a model farmer who was honored by the community residents for his agricultural knowledge that was effectively transferred to interested people. Case study 9 Date Orchard where the farm owners graduated with B.A. Degrees, got married, spent their lives in Bangkok for about 5 years, and then wanted to spend their lives in their

hometown, they started with farmer profession and grew vegetables and sent them to middleman who sold them at Si Mum Mueang Market. While growing vegetables, they were trying to seek other economic crops appropriate to the climate with simple care and with good income. They searched for information and came to the conclusion to grow dates through tissue culture on the land of 5 rai with relatively abundant output and sold on online market. At present, the farmers form themselves in group to expand the land to grow dates on the additional land of 20 rai with the intention to practice eco tourism in the future. Case study 10 Bangkachao Farm with the first inspiration to have good quality of life for the owner's 2 children with studying age. So, the owner decided to resign from work in Bangkok and moved his family to the same plot of land that his mother used to grow oranges but then suspended the operation and turned to the plantation of other crops but did not meet with success due to water problems. When restarting the practice of farming, he used different method than his mother and attended trainings for additional knowledge on agriculture. He started with salad farm, worm breeding, and mushroom culture. He learned through long experience until he met with success. At present, he received good support from both the public and the private agencies resulting in the farm's progress.

The 10 case studies mostly started with farming practice with knowledge of local wisdom from ancestors with trial and error and with the output that did not constitute cost effective investment. Later, the farmers sought additional knowledge and received support from the government. They used modern IT tools and technology with advanced system and process in farming until they acquired good output with safety and standard in the production process. Knowledge was provided on planning prior to production as well as marketing and online marketing planning to successfully sell products. Moreover, knowledge was transferred on output processing, diverse goods to develop and increase value of the goods benefitting the Smart Farming, customers, and consumers. As a result, the economy based on agriculture greatly expanded. Ministry of Agriculture and Cooperatives set the guideline to develop the agricultural sector to support the economic and social changes and shift to the new agricultural model such as Project of Smart Farming and Precision Farming with the development of Agritech and Innovation Center (AIC) by

linking with Agricultural Productivity Efficiency Increasing Learning Center to upgrade modern agriculture and precision agriculture and Project of Environmental-Friendly Agriculture with the promotion of sustainable agriculture as immunity and security for farmers, and the development of Thai food in response to the demand of safe agricultural goods for 5 establishments namely school, hotel, hospital, prison, and restaurant, and Strengthening Farmer Institution with the promotion of processing of agricultural goods to serve as the community agricultural products, promote farmer institution, entrepreneur, and Start Up as Agriculture Service Providers (ASP) such as maintenance technology, tractor for soil preparation and harvest to order to provide comprehensive services to the farmers (Office of Agricultural Economics, 2017).

5.1.2 Strategy to Drive the Policy of Smart Farming in Urban Community

The strategy to drive the policy of Smart Farming in urban community was crucial to contribute to the success of Smart Farming. Without the good strategy to drive the policy of Smart Farming in urban community, the practice might fail. The drive and promotion of Smart Farming was important as follows: with the limited land use for Smart Farming urban community, farmers could not expand the land in line with the demand of the market due to excessively high prices and most land was speedily developed as residential community. In order to mitigate the impact on the uncontrollable pollution and environment, incentives should be increased to enable farmers to turn to Smart Farming such as cost-effectiveness, chemical-free goods, etc. Clear and continuous support from the government policy was still needed. The knowledge on Smart Farming of residents in urban community required the use of technological equipment to assist in production process. Mostly it was Platform or Application appropriate to farmers with large plots and more ready in terms of capital than general farmers who were poor. The drive and promotion of Smart Farming from government agencies included the following: Office of the National Economic and Social Development Council formulated the 13th National Economic and Social Development Plan effective between 2023-2027. It determined the development into 13 milestones as the factors to drive the development with the target and the direction

to help support the country's transformation. Milestone 1: Thailand is a leading country of agricultural products with processed agricultural products with high value and focus on the value creation of agricultural and processed agricultural products by using technology and innovation, increase efficiency of agricultural basic infrastructure and support the role of agricultural entrepreneurs. Ministry of Agriculture and Cooperatives used Part 4 of the Strategic Plan Milestone 1 of 13th National Economic and Social Development Plan to determine Thailand as a leading country in processed agricultural products with high value to generate revenue into the country through the expansion of cultivation land, development of factors of production with quality, continuous development and technology to increase production efficiency to a certain level.

The economic activities relevant to the production of agricultural products, food industry, and beverage industry had the combined value of 74.5% of the GDP of the agricultural sector and the relevant processing in 2019 (Office of National Economic and Social Development Council, 2022) and the 20-Year Agricultural Strategy (2017-2036) by Ministry of Agriculture and Cooperatives promoted the strength and mitigated the weakness in order to facilitate the agricultural development in the long run to meet the vision of "Secure, prosperous, and sustainable agricultural sector" by strengthening the farmers and farmer institutions to increase production efficiency and upgrade the standards of agricultural products in order to increase the competitiveness of the agricultural sector with technology and innovation, management of balanced and sustainable agricultural resources and environment, as well as development of public sector management.

The interesting issue was Strategy 1: Strengthen farmers and farmer institutions with the following targets: 1) Average income of farmers 390,000 baht/person 2) All farmers are Smart Farmers 3) Farmer institution is strong at the levels 1 and 2 at 95%, with the development guidelines as follows: 1) Strengthen farmers and farmer institution, Smart Farmer, Smart Group, Smart Enterprise 2) Promote pride and security in farming profession 3) Management of agricultural labor force by applying innovation and technology, with the following indicators 1) Per capita income of farmers (baht/person) 2) Percentage of farmer who is Smart Farmer per farmer at working age (aged 18 - 64 years old) 3) Percentage of farmers are strong

based on standard 4) Number of farmers are members of farmer institution (average of 15 persons per group), and 5) Happiness indicator of farmers should use technology appropriate to the work of farmers in tandem with the farmers' existing knowledge which will be an important step towards the success of Smart Farming. At present, many farms apply this technology at work. Various tools are used to control and manage farms such as precision watering and fertilizer application system. So, it is no longer necessary to forecast the amount of fertilizer. Tool or sensor may be used to control the temperature, humidity, pH adjustment, and soil richness. Moreover, importance is placed on environment, water, and soil for optimal use with focus on initial safe agriculture prior to develop safe agriculture at another occasion. The government's development and cooperation policy will strengthen farmers for sustainable development and higher economic competitiveness.

The drive and promotion of Smart Farming from the private sector included the following: the government should clearly and concretely set the policy of Smart Farming such as for the empty space in urban community, knowledge from the research from universities should be developed for model farms in various communities for farmers and interested persons to come and learn as well as train to become successful Smart Farming practitioners. The government should support the use of Smart Farming technology for farmers to widely use it at appropriate prices which would benefit the overall farming of farmers and create higher security in the country's economic system. The drive and promotion of the Smart Farming from public organizations included the following: there were 3 major components of smart farming which would ensure efficient smart farming such as identification of the position of cultivation land, analysis of information in line with the period of plant cultivation and area management with appropriate technology without excessive use of resources and in consistency with the cultivation of particular plants. The drive and promotion of Smart Farming from academic institutions included the following: research relevant to Smart Farming. At present, the government formulates the policy on budget to conduct research work but farmers cannot implement the research work. It is still suitable for government agencies to use as prototype farm or demonstration farm. At present, university work is divided into 2 parts namely academic work directly for the government requiring quite a lot of budget and the tools are expensive.

As for the research that the knowledge is used to provide training to farmers, it is research work that is relatively modern and cheap. At present, academic institutions attract interest from the private sector who directly gives financial support to universities to organize trainings on Smart Farming to farmers. Moreover, financial support is also destined to universities for academic research in view of academic development. It is jointly developed between the public sector and the universities. Smart Farming should also use technology that is appropriate to the model, guideline, and methods of Smart Farming. The farmers themselves must also have knowledge and ability to develop and improve technology appropriate to usage so that it can enhance on the farmer's work or the work of the member friend in the cooperative, and community enterprise to ensure that the work will succeed. The application of technology that does not match work will be a waste and not cost effective. It also adds unnecessary burden of costs for Smart Farming. The importance of technology which was the main issue that Smart Farming must consider as the first priority was the ability to develop and increase the efficiency of production process to attain standard, save costs in terms of timeframe and labor costs. The output with quality, standard, and safety would benefit customers and consumers. The application of technology to ensure success of Smart Farming included the following: IoT (Internet of Thing) which aimed to manage farm efficiently using the least labor force, the use of technology of RFID Sensors to connect with agricultural equipment to enable the equipment to communicate with the main controlling equipment, and the sensors included the following: Weather Station, Soil Sensor, Plant Disease Sensor, Yield Monitoring Sensor. These sensors could be arranged into the Wireless Sensor Network through installation or in the fields to collect information such as humidity in the soil, temperature, amount of light, and chemicals to know how much fertilizer, water, and pesticide could be used from different areas.

In summary, there was the drive of government agencies at the policy level with clear formulation and implementation of plans and projects with responsible personnel, as well as monitoring of the operation in all processes. As a result, the drive of the policy of Smart Farming in urban community met with success. Moreover, there was cooperation from the business and private sectors to render support to Smart Farming in urban community in order to strengthen and advance the

progress of Smart Farming to increase the efficiency of production standard and safety, upgrade the standard of agricultural products to attract consumers' popularity, increase competitiveness of the agricultural sector through technology and innovation, and balanced and sustainable management of agricultural resources and environment.

5.2 Gaps Implementing the Relevant Policies, Strategies, and Plans

5.2.1 Policy

“Smart Farming” was the use of technology for management to control, inspect, collect information, analyze, or solve problems in farming through the construction of system or the usage of light sensor, humidity, and temperature to facilitate farmers' work, with reduced costs and increased output without spending time and money in the traditional farming. The examples in the past included the application of the concept of agricultural innovation in the agricultural sector such as the use of drone to explore the cultivated land, the use of tractor to reduce the burden of workers, the use of high precision devices to modify the ratio of fertilizer, the amount of water, and light reception, the design of automatic irrigation system, the use of GPS technology to inspect the area conditions, climate, to reduce the risk of the spread of pests and natural disasters, chicken farming with the sensors of humidity, temperature, light intensity, and other factors impacting growth or smart greenhouse installed with the system to monitor the climate change and control of vapor spray to reduce temperature. The Smart Farming Action Plan 2022-2023 and the National Strategy 2018-2037 would determine the direction of smart farming and systematically lay down the foundation of the country's smart farming. The relevant agencies under Ministry of Agriculture and Cooperatives and other agencies could apply the project proposal set under this smart farming action plan as the project proposal of the agency to drive the country's smart farming with focus on Smart Farmer and Young Smart Farmer with the hope to concretely develop smart farming in big plots in all the provinces nationwide and with access to all districts within 3 years for concrete results in accordance with the goal of the national strategy on agriculture.

However, although technology was increasingly used to manage farming at present, it must be recognized that in Thailand it was still in its initial stage. As Smart Farming required development and support from many sectors including the public and the private sectors, the farmers themselves must learn, develop themselves, and ready to shift from the traditional ways of life. The government should promote the development of farmers' potential to have access and utilize agricultural technology and innovation in terms of knowledge, breeding, factors of development, agricultural machine and equipment, capital for practicing the profession, and personnel development to prepare agencies to serve as trainers to farmers. The private sector should support the access to technology, production process, processing of goods and value creation to agricultural goods leading to income for the farmers in applying agricultural innovation or other novelties and modifying the model of traditional management or the enhancement of the farming profession. Smart Farming was the project that the government rendered a lot of support and interest, as well as a lot of budget with the expectation that the project would succeed in upgrading the quality of life of the participating farmers which would make their livelihood better in tandem with the country's economic stability and security.

5.2.2 Environment

Thailand is one of the developing countries greatly affected by the climate change. As most of agricultural lands in Thailand constituted an agricultural system that mainly relied on rainfall, the climate change in various forms such as higher temperature, or the rain distribution during the rainy season that changes in the future would directly impact agricultural output. But Smart Farming was the agricultural practice that was different from traditional farming in terms of the use of resources, factors of production with precision and in accordance with the demand of plants in terms of water and fertilizer to reduce loss and excessive demand for plants impacting the environment. The government should focus on city plan management to control the areas inside and outside the areas for Smart Farming in order to grow and expand on a systematic and balanced basis, by developing the agricultural land to serve as buffer zone for conservation forests, as well as promote and support Smart Farming through research and budget allocation to develop the dimension of the relationship in

parallel with the environment. Smart Farming contributed to reducing eco footprint from the normal agricultural practice by applying the least factors of production for sustainable development such as fertilizer and pesticide. Precision farming would reduce the problems of erosion and greenhouse gas emission. Smart Farming helped farmers better understand major factors such as water, terrain, types of plants and soil, and ensure that the farmers could determine the use of limited resources to the best of their interest in their production environment and manage these factors for sustainable environment. Smart Farming was environmental-friendly and reduced agricultural pollution by reducing the consumption of fertilizer and herbicide while reducing erosion and greenhouse gas release, and reducing the use of chemicals by replacing them with compost which would increase safety to farmers and consumers and to ensure that the output was safe to growers, customers, and consumers and also environmental-friendly.

5.2.3 Technology

The present shift from Traditional Farming to Smart Farming placed importance on the country's economic development with the use of technology to promote agricultural practice with focus on management and use of electronic technology and computer as well as IT to develop and facilitate agriculture for efficient production process and output that was safe for consumers with the application of IoT (Internet of Thing) and various devices such as sensors, control system, robots, autonomous car, smart hardware, technology for applying fertilizer/water/pesticide, and others to control and solve the agricultural problems in order to reduce costs. The control of Smart Greenhouses was one method to increase output and control environmental variables through the IoT which would reduce output loss and unnecessary energy loss. The environment of smart greenhouse could control water system, air ventilation and air conditioning system, lighting system and other sensor systems to greatly reduce unnecessary inspection by the farmers themselves or the labor force. Moreover, Smart Farming used AI (Artificial Intelligence) or the machine with the functions to understand and learn knowledge such as perception, learning, reasoning, and problem solving to help at work. The use of AI would ensure that farmers could efficiently manage the agricultural system such

as compilation of information on the weather, temperature, variables, methods of the old generation of skilled farmers using the Eye Camera to collect moving picture while practicing agriculture in order to feed the information to the AI for processing, analysis, and summary in order to give advice to ordinary farmers, etc., the use of Big Data, the installation of the sensor system, or information collecting devices such as Drone to collect information.

The AI (Artificial Intelligence) was used for efficient analysis, comparison, decision-making, and advice to farmers (Chatbot) based on Real Time. At present, some farmers viewed Smart Farming as relatively new and modern which required a lot of capital to invest in equipment and installation of technological systems, as well as a lot of knowledge and understanding. So, farmers were rather concerned about the risk from investment loss. However, most entrepreneurs and farmers were interested and perceived Smart Farming as important in the future. This was in line with the situations of the increased demand and consumption of agricultural yields in Thailand while the cultivation areas were unchanged. Thailand's agricultural sector should systematically develop in terms of advice for the appropriate cultivation of plants and increased output per rai. Farmers should also experiment and develop farming with new methods and open to changes in agricultural business. The farmers should also understand technology and the use of appropriate technology to increase output and enhance on the business for future security.

5.2.4 Standard

In terms of Smart Farming, to ensure that the agricultural output would have quality and standard in line with the demand of the market and environmental-friendly, the standard of production process should be set to ensure that the output from Smart Farming in urban community had good quality and was safe with the same standard nationwide. In terms of safe farming, Smart Farming should focus on cooperation of G.A.P. (Good Agricultural Practice) to promote knowledge and understanding of production process with standard to prevent or mitigate the risks of danger during cultivation, harvest, and post-harvest to obtain the output that had quality and the output that was safe and suitable for consumption. The public and the private sectors should also support R&D, and continuous transfer of modern

technology on Smart Farming in urban community to entail learning, promotion, development of farmers' ability and skills in the production process standard, with readiness to deal with the technological changes at a higher level, and cooperation with domestic and foreign experts to create network to jointly create the output standard from Smart Farming to have quality and safety recognized with the confidence of customers and consumers.

5.2.5 Quality

In terms of agricultural and food innovation, as the trend of the global agricultural sector and food was rising, the producers and consumers were more directly in relationship. The advanced science and technology resulted in increased efficient production, convenience, comfort, and healthcare assumed a more important role. The agricultural goods and food that could survive would require innovation and safety. During the social transformation to the new era, the farmers were developed as Young Smart Farmer and Smart Farmer to become SMEs Startup Social Enter, with the use of Smart Agriculture from production, processing, market with safe goods, upgraded value, quality, and standard in parallel with savings of water and optimal agricultural land use by using the precision Smart Farming as an important role in Smart Farming. Smart Farming would reduce costs in many aspects, increase output, forecast the production process with precise output quantity. Therefore, Smart Farming was continuously developed in terms of inspection of output quality, control of cultivation, resource management used in Smart Farming which would reduce complications in learning of Smart Farmers and facilitate them with existing experience to more efficiently manage the Smart Farming which would result in the output with good quality, standard, and safety well recognized by consumers.

5.2.6 Basic Infrastructure

The basic infrastructure for Smart Farming included smart greenhouse and plant producing factories to develop plant breeding appropriate to the environment to increase agricultural output and reduce the cultivation time. Moreover, the necessary basic infrastructure for Smart Farming was high speed internet which was accessible to every village in Thailand. It was therefore a success factor to drive Thailand's

Smart Farming and digital system must be developed in the chain to serve as Smart Agri-Logistics as agricultural goods were perishable within a limited period and prices fluctuated according to the freshness of the goods, and the trend of future consumption of agricultural goods dictated that consumers wished to know the sources of information of production, duration of harvest, avoidance of chemical methods, or contamination for safety, quality, and freshness of the agricultural goods. Therefore, the major factor to maintain the freshness from plots to consumers' plates would depend on the time used for transporting agricultural goods which must be appropriate to deliver the goods to the required market within the timeframe.

5.3 Success Factors Impacting the Sustainable Smart Farming of Farmers in Urban Community

Based on the study findings of the success factors of Smart Farming through the factor analysis of the 10 case studies of the Smart Farming entrepreneurs, it revealed that the success factors of Smart Farming are as follows:

5.3.1 Commitment and Determination

Commitment and determination are key principles for the success of Smart Farming. Farmers must strive to manage their farms efficiently and overcome potential obstacles. They should have a deep love for and cherish their land and farming career and intend to pass on this passion to the next generation. Determination and determination help farmers stand through the challenges, and find solutions ensure the success of their farming endeavours.

5.3.2 Ability to Use IT Tools

Smart Farming relies on technology and IT tools to improve agricultural practices. Farmers need to keep up with agricultural knowledge and use IT devices to access information, manage processes on the farm and make informed decisions. IT technologies such as IoT devices and sensors can help monitor and control various aspects of farming including temperature, humidity, fertilizing and watering. Farmers can also use online platforms and social media to market their products, production planning and connect with customers.

5.3.3 Ability to Marketing and Online Marketing Planning

Marketing planning and online marketing are essential for the success of Smart Farming. Farmers need to develop effective marketing strategies to sell their agricultural products and meet market and consumer needs. Online marketing through platforms like Facebook, Twitter, and YouTube can be a cost-effective way to reach potential customers. Gather market insights and build relationships with consumers Smart Farmers should adapt to the online market trends and leverage the power of social media to increase their sales and market share.

5.3.4 Attendance of Trainings for Additional Knowledge

Continuous learning and participation in training programs are important for Smart Farmer. Farmers should strive to increase their knowledge and skills in areas such as management, marketing, digital tools, and appropriate technology Training and seminars organized by both government and private sectors Providing valuable insights and updates on successful farming practices, Smart Farmer can learn about new technologies, able to adapt to changing situations and able to pass on knowledge to other farmers and later youth.

5.3.5 Recording and Income-Expenditure Accounting

Income-expense accounting is an essential tool for Smart Farmer. Farmers can track their source of income, expenditure and financial transactions by keeping detailed records. This helps to review and plan expenses, production cost control and identify areas where savings can be made Effective accounting practices provide financial stability, better decision and the ability to manage loans and investments.

5.3.6 Sufficiency Economy Farming, Organic Farming, and Integrated Farming

Smart Farming can combine different types of farming such as sufficiency economy farming, organic farming and integrated farming Sufficiency Economy Agriculture under the Royal Initiatives of His Majesty King Bhumibol Adulyadej emphasizing sustainable and balanced practices in harmony with nature and cost-

effective use of resources. Organic farming focuses on environmentally friendly and sustainable production methods. Reduce the use of artificial chemicals and hormones. Hybrid farming involves growing different crops or raising livestock on the same land. Maximize efficiency and benefit from interactions between plants, animals and the environment.

5.3.7 Support from the Public, Private, and Business Sectors

Smart Farming requires investment and support from the government, private sector and businesses. Government plays an important role in educating financial support and policies to promote Smart Farming, government agencies such as the Ministry of Agriculture and Cooperatives Formulate an action plan and policy to drive Smart Farming and improve the quality of life of farmers. Private companies and businesses Also contributed by the development of innovative technology. organization of training programs and offering services that support the Smart Farming initiative.

5.3.8 Knowledge on Agricultural Practice from Ancestors

Traditional knowledge and wisdom handed down from generation to generation are valuable assets for Smart Farmer. Many farmers have learned farming from their families and ancestors. acquire skills and knowledge from an early age Local wisdom on community basis.

5.3.9 Output with G.A.P. Standard

To ensure the safety and quality of agricultural products Farmers should follow Good Agricultural Practices (G.A.P.), Department of Agriculture. Ministry of Agriculture and Cooperatives Set regulations and standards for crop production according to international principles. Using G.A.P. helps farmers produce safe agricultural products that meet the needs of both domestic and international markets.

5.3.10 Forming of Group for Shared Agricultural Practice

To overcome the challenges and limitations that individual farmers face. The government therefore promotes the establishment of farmers' groups to join together

in farming. This concept is in line with the philosophy of sufficiency economy and aims to enhance the livelihood of farmers by empowering them to bargain collectively. Cost-sharing opportunities and access to knowledge and technology.

The importance of government support using traditional knowledge Adherence to quality standards and the establishment of a farmer group to drive the success of Smart Farming in Thailand. Large-scale farming in Thailand requires strong government support and policies for farmers to succeed. Here are some key policies in support of large-scale farming:

Investment promotion: The government should provide financial support and encourage investment in large-scale farms, for example by providing funds to enable farmers to purchase necessary agricultural equipment and technology. Increase access to credit and offer favorable interest rates for agricultural investments. This includes supporting market research and creating business opportunities for farmers.

Human Resource Development: The government should promote agricultural training and skills development for farmers to increase their knowledge and expertise in farming. by establishing an agricultural training center Agricultural consulting services and support researchers and academics in agriculture

Technology and innovation support: The government should promote research and development of agricultural technology to increase productivity and efficiency. This includes developing disease-resistant crop varieties and implementing smart farming technologies such as sensor-based field management systems. to increase production efficiency

Creating markets and facilitating wholesale trade: Governments should support the establishment of strong markets for agricultural products and facilitating wholesale trade to add value to farmers. This can be done by supporting local agricultural markets. Facilitating the export of agricultural products Developing an efficient distribution network and creating opportunities to access new markets

Sustainable policy management: Governments should develop sustainable policies that support large-scale farming and meet environmental considerations. This includes improving access to water and farmland. Promoting the use of alternative energy sources in agriculture and supporting natural resource management.

Implementation of these policies The government can provide a favorable environment for large-scale farming in Thailand. Make farmers successful and participate in the development of the country's agriculture.

5.4 Summary of the Appropriate Model Impacting Success of Smart Farming

Based on the in-depth interviews with farmers in 10 case studies who practiced Smart Farming in urban community, the information was analyzed to find the covariate through the selection of 10 repetitive factors for analysis. The study findings revealed that based on the presentation of the model of sustainable Smart Farming in urban community with the use of the conceptual framework of the model of Smart Farming through online meeting of the Smart Farming entrepreneurs in 10 case studies, the recommendations on the appropriate model of Smart Farming are summarized as follows:

5.4.1 Appropriate Model for Smart Faming

The information from the study was used to construct a model and receive opinions of farmers and concluded in the following model:

Appropriate Model for Smart Faming The information from the study was used to construct a model and receive opinions of farmers and concluded in the following model:

Input	Operations	Output	Impact
Personnel: Knowledge and advanced technology of Smart Farming Budget: Form groups to seek funding from National Innovation Agency Tools and equipment: Equipment of IoT (Internet of Thing) Acknowledgement of Smart Farming: the government should have clear policy Knowledge and understanding: There should be exchange, learning, and experience Awareness of product quality: Cooperation must be forged to ensure output with standard.	Planning: Production planning in line with seasons and market demands of customers and consumers. Operation: Selection of technology appropriate to environment with optimal usage. Monitoring and assessment: Long-term should be considered on the appropriateness Development and improvement: Aimed to ensure that farmers were equipped with knowledge and expertise in agricultural practice in the entire value chain.	Income: Focus on marketing and online marketing that places importance on standard and safe production process Yield: Production process should be developed for standard, and safety and technology should be used to increase output.	CSR: Sustainable production process should be supported with focus on quality goods, least impact on the environment, especially efficient resource management such as optimal resource utilization. Sustainability: 6 qualifications of Smart Farming: Technology is used and appropriate to the concept of Smart Farming. Environment: Smart Farming must adapt itself more in terms of climate change and pests which evolve a lot than in the past, residual chemicals, Smart Farming must take into account own environment Quality of life: Importance placed on the good knowledge and understanding of the perception of Smart Farming and production planning, online marketing planning, quality and safe Smart Farming. Circular economy: Awareness of the value of surrounding things, reuse, repair, re-production, as well as improvement of business model, innovation, and follow-up to manage products.
 To present a sustainable Smart Farming model for Urban Community			

Figure 5.1 Summary of the Appropriate Model Impacting Success of Smart Farming

5.4.2 Input

Personnel: Knowledge and advanced technology of Smart Farming should be developed, study tours of the successful Smart Farming prototype should be organized, as well as online meetings for additional knowledge

Budget: Form groups as cooperative or community enterprise to seek funding from National Innovation Agency or National Research Council of Thailand

Tools and equipment: Focus on the use of the equipment of IoT (Internet of Thing) system to assist in production process more in order to solve the problem of the labor shortage in the agricultural sector

Acknowledgement of Smart Farming: Search for additional online information, the government should have clear policy

Knowledge and understanding: There should be exchange, learning, and experience of knowledge of Smart Farming on a mutual basis with adjacent areas

Awareness of product quality: Cooperation must be forged to ensure certified output with standards but farmers were concerned about danger from chemicals and wanted the government agencies to enforce strict inspection as at present only 6 chemicals were inspected for safety standards

5.4.3 Operations

Planning: Production planning in line with seasons and market demands of customers and consumers, the period where there are a lot of insects and pests must be avoided

Operation: Selection of technology appropriate to environment with optimal usage, not excessive, and not creating burden in terms of costs

Monitoring and assessment: Long-term should be considered on the appropriateness of the calculation of the break even point and not short-term consideration

Development and improvement: Aimed to ensure that farmers were equipped with knowledge and expertise in agricultural practice in the entire value chain of agricultural production in line with their lifestyle and nature of operation of each individual farmer

5.4.4 Output

Income: Focus on marketing and online marketing that places importance on standard and safe production process

Yield: Production process should be developed for standard and safety and technology should be used to increase output because at present labor costs in production process of agricultural goods are very high

5.4.5 Impact

CSR: Sustainable production process should be supported with focus on production process with quality and with the least impact on the environment, especially efficient resource management such as optimal resource utilization, reduced waste, reprocessing of waste for reuse, in line with the concept of sustainable development and CSR of the farm, under the ethical principles and good management of CSR both in and outside the farm

Sustainability: For the 6 qualifications of Smart Farming, technology should be used that is appropriate to the concept of Smart Farming, farmers must have knowledge and ability to develop and improve technology that is appropriate to usage and enhancement on their work or their cooperative member friends to succeed, and not the usage which is not appropriate at work which would be a waste and not cost effective and add unnecessary costs in practicing Smart Farming

Environment: Smart Farming must adapt itself more in terms of climate change and pests which evolve a lot than in the past, residual chemicals, Smart Farming must take into account own environment for example how near it is to the area where chemicals are used, buffer zone must be designed to prevent the disturbance of the chemicals or the contamination in their yields. Smart farmers must adapt themselves to the environment in each area and create good environment in their plots.

Quality of life: Importance placed on the good knowledge and understanding of the perception of Smart Farming and production planning, marketing planning, online marketing planning, quality and safe Smart Farming, focus on Good Agriculture Practices (G.A.P.) and sell to consumers in full quantity. If the goods are not sold out, planning must be formulated to process the output and increase value to

agricultural goods to ensure that the Smart Farming entrepreneurs earn good income from the sales of output and goods.

Circular economy: Awareness of the value of surrounding things, reuse, repair, re-production, as well as improvement of business model, innovation, and follow-up to manage products and materials to circulate within the system, reducing waste from production, increasing output, reducing consumption of energy resource, and support of each farmer to collect information on environmental management within his or her own farm to proceed with carbon credit.

5.5 Discussion

Based on the research results, the discussion was as follows:

5.5.1 Smart Farming in Urban Community as well as Problems and Obstacles

Based on the study, it was revealed that the success component of Smart Farmer consisted of the knowledge of the current activity and ability to serve as lecturer to provide technology transfer or advice to others, the previous invitation as lecturer in various forums, the ability to serve as model farmer or point of learning to others, previous visits by others to the farmer's plot, the farmer had information for decision-making, production system, and marketing, the ability to gain access to information from government officials and through IT technology system and other communication channels such as Internet, Mobile Phone, Smart Phone, etc. , acquaintance and regular contacts with the government officials at Ministry of Agriculture and Cooperatives for queries of information, use of information to solve problems and develop one's profession, output and marketing management, ability to manage factors of production, labor, capital, etc., Zero Waste Management, processing of agricultural residues into goods for sales, awareness of product quality and consumer safety, knowledge or training on the standards of G.A.P., G.M.P., organic farming, or other standards, production process that did not generate pollution or destroy environment (Green Economy), use of bio technology to manage pests, reduce the use of chemicals to get rid of pests, pride of being farmer, commitment to practice farming profession, love and cherishment of the land and farming profession

for the next generation, happiness and satisfaction in practicing farming profession. Based on the study results of the 10 case studies of Smart Farming, there were 6 basic qualifications of Smart farmer as follows: (Smart Farm (Thailand), 2015).

1) Knowledge in the current activity, ability to serve as lecturer to transfer agricultural technology or to give advice to other interested persons. The study results revealed the following: Case study 1 Hydroponics Vegetable Farm served as a location of study tours for students of the B.A. and M.A. degrees from various universities. Case study 2 Melon Farm served as a learning center to increase efficiency in production of agricultural goods. Case study 3 Suanlungthod served as a location of study tours for students of the B.A. and M.A. degrees from various universities. Case study 4 Suanpanisara transferred knowledge on the process of tie dye fabric from guava leaves in cooperation with Nong Nok Khai community enterprise. Case study 5 Mushroom Farm collaborated with Department of Agricultural Extension to transfer knowledge on mushroom culture. Case study 6 Riceberry rice was supported by Provincial Energy Office-Nakhon Pathom to serve as a location of study tours for farmers and those interested in rice mill run by solar cells. Case study 7 Pomelo Orchard where the owner served as lecturer to disseminate knowledge on the use of organic fertilizer. Case study 8 Integrated Agricultural Garden was a model garden based on the Sufficiency Economy. Case study 9 Date Orchard was a location of study tours for farmers interested in date cultivation. Case study 10 Bangkachao Farm was a location of study tours on organic farming.

2) In possession of information for decision-making, ability to have access to information sources from government officials and through IT technology system and other communication channels such as Internet, Mobile phone, Smart phone, etc. Case study 1 Hydroponics Vegetable Farm had information on vegetable cultivation from advanced orders. Case study 2 Melon Farm with use of smart phone to inspect the work of IoT devices. Case study 3 Suanlungthod used smart phone to search for additional information and knowledge. Case study 4 Suanpanisara searched for additional information and knowledge via YouTube with smart phone. Case study 5 Mushroom Farm used smart phone for online meeting with official from Department of Agricultural Extension. Case study 6 Riceberry rice used smart phone for online meeting with official from Rice Department. Case study 7 Pomelo Orchard

used smart phone for online meeting with official from District Agricultural Extension Office. Case study 8 Integrated Agricultural Garden regularly received information and news from government officials. Case study 9 Date Orchard used smart phone for online meeting with official from District Agricultural Extension Office. Case study 10 Bangkachao Farm used smart phone for online meeting with officials from District Agricultural Extension Office and from Provincial Agricultural Extension Office.

3) Output and marketing management, ability to manage factors of production, labor, and capital, ability to link production and marketing to sell output, as well as zero waste management. Case study 1 Hydroponics Vegetable Farm with the ability to receive advanced orders before cultivation. Case study 2 Melon Farm processed residual output into melon ice cream. Case study 3 Suanlungthod operated efficient production process without waste and without damaging the environment. Case study 4 Suanpanisara with the ability of good production and marketing to sell Gimju guava. Case study 5 Mushroom Farm with the ability to process residual material from mushroom culture as fertilizer to grow lemon, reduce waste, and increase income. Case study 6 Riceberry rice practiced agriculture with great emphasis on environment without burning rice stubble and generating pollution. Case study 7 Pomelo Orchard was organic farming with safe output for consumers. Case study 8 Integrated Agricultural Garden could grow banana that was in accordance with the demand of the market. Case study 9 Date Orchard managed the sales of date in line with the demand of consumers. Case study 10 Bangkachao Farm could efficiently manage production process and marketing for the sales of salad.

4) Awareness of product quality and consumer safety, knowledge or training on the standards of G.A.P./G.M.P., organic farming, or other standards. Case study 1 Hydroponics Vegetable Farm produced output certified with the Global G.A.P. standard. Case study 2 Melon Farm produced output certified with the G.A.P. standard. Case study 3 Suanlungthod used to attend training on the G.A.P./G.M.P. standards. Case study 4 Suanpanisara used to attend training on the G.A.P./G.M.P. standards. Case study 5 Mushroom Farm used to attend training on the G.A.P./G.M.P. standards. Case study 6 Riceberry rice used to attend training on the G.A.P./G.M.P. standards. Case study 7 Pomelo Orchard had good knowledge on

organic farming. Case study 8 Integrated Agricultural Garden and Case study 9 Date Orchard Farm used to attend training on the G.A.P./G.M.P. standards. Case study 10 Bangkachao Farm produced output certified with the G.A.P. standard

5) CSR with production process that did not generate pollution and did not damage the environment (Green economy) with continuous CSR activities. Case study 1 Hydroponics Vegetable Farm operated good production process with standard and export to Europe. Case study 2 Melon Farm focused on clean and safe production especially in production process. Case study 3 Suanlungthod focused on zero waste in production process. Case study 4 Suanpanisara served as a learning center of Nong Nok Khai community enterprise with standard and CSR. Case study 5 Mushroom Farm operated good production process without waste that polluted the environment. Case study 6 Riceberry rice operated production process with environmental responsibility without agricultural waste burning. Case study 7 Pomelo Orchard focused on organic farming without the use of chemicals to preserve the environment. Case study 8 Integrated Agricultural Garden focused on bio fertilizer to preserve the environment. Case study 9 Date Orchard practiced social responsibility without agricultural waste burning. Case study 10 Bangkachao Farm was socially responsible with production process that did not pollute or destroy the environment (Green economy).

Item 6: Pride of being farmers with commitment to practice farming, love and cherishment of the land and farmer profession for the next generation, happiness and satisfaction of practicing farming profession. Case study 1 Hydroponics Vegetable Farm where the owner was proud to be farmers. Case study 2 Melon Farm where the owner was committed to farming profession. Case study 3 Suanlungthod where the owner was happy and satisfied with the farming profession. Case study 4 Suanpanisara where the owner loved and cherished the land and farming profession for the next generation which would be her daughter. Case study 5 Mushroom Farm where the owner was proud to be farmer. Case study 6 Riceberry rice where the owner was proud to be farmer. Case study 7 Pomelo Orchard was determined to practice farming profession. Case study 8 Integrated Agricultural Garden where the owner loved and cherished the land and the farming profession for the next generation. Case study 9 Date Orchard where the owner was determined to practice

the farming profession. Case study 10 Bangkachao Farm where the owner was determined to practice the farming profession.

5.5.2 Success Factors of Smart Farming in Urban Community

The study findings revealed that the 10 case studies of the Smart Farmers in urban community with the success factors in practicing Smart Farming in urban community consisted of commitment which was a major principle of success factors. Smart Farming involved process and technology. Without commitment and determination, the farmer might be discouraged and disheartened which might lead to failure. The qualification item 6 of Smart Farming identified the following: pride of being farmer with the indicator as commitment in practicing farming profession, love and cherishment of the land and the farming profession for the next generation, and happiness and satisfaction in practicing farmer profession (Department of Agricultural Extension, 2013). Apart from commitment and determination, the ability to use IT tools was also important for farmers who practiced Smart Farming with the details and processes of farming that were different from traditional farming especially the use of technology that required knowledge and news from the use of IT tools.

IT tools were indeed crucial in contributing to the Smart Farming success. As the concept of IT and agricultural development, Plooksakul (2013) identified agricultural IT as the main foundation and necessity that was indispensable in Thailand's agricultural development. IT was the source of knowledge and technology that would create value added and develop knowledge in terms of production, marketing management, and product processing. The knowledge from the use of IT devices would result in the ability to plan marketing and online marketing. The importance of marketing planning for Smart Farmers was to generate income for the farmers for the sales of output and the guideline to develop and improve output in line with the demands of market and consumers all the time, and expand production which would be beneficial to customers as customers and consumers had the demand of goods and output from the Smart Farmers. Moreover, the website on online agricultural market (Talatkasattrakon Online, n. d.) by Department of Agricultural Extension serves as an coordinating channel to deliver agricultural goods with good quality from the work of real farmers nationwide under the supervision of the

Department, including Smart Farmer (SF), Young Smart Farmer (YSF), farmer group in big plots, community enterprises, and other farmer organizations from every province nationwide to the hands of the consumers under the slogan “Real farmers, Safe goods, Upon order, and Prompt delivery.” (Talatkettrakon Online, n. d.).

The other important factor was to attend trainings for additional knowledge. It was necessary for Smart Farmers to increase knowledge. Therefore, training was important to support, promote, and develop farmers to practice Smart Farming with knowledge and ability for production, management, marketing, digital skills, appropriate use of technology that facilitated adaptation in changing situations, as well as model farmer to transfer knowledge to other farmers, and encourage the new generation to enter the agricultural sector and undergo the development to become Young Smart Farmer with the systematic process of development and creation of network, support the use of ICT (Information and communication technology), new technology, innovation, creativity to develop and upgrade farming entrepreneurs and as a main driving force to develop new agriculture through integration with all relevant sectors (Department of Agriculture Extension, 2022). The ability to record and prepare income-expenditure account was also important. The recording and income-expenditure accounting for Smart Farmers was a valid indicator of practicing a profession. The income-expenditure recording would enable farmers to know how much was the income and the expenditure to ensure the development of sustainable agriculture. The income-expenditure accounting was an important tool that would assist farmers in monitor and plan spending, control production costs, as well as unnecessary spending to reduce it and increase savings which would increase the ability for loan payment of the farmers (Pimrak Phumcharern, 2016).

Moreover, Smart Farming would be able to apply agricultural knowledge according to the Sufficiency Economy farming, organic farming, and integrated farming with success and benefit in terms of output and sustainable environment in different combined guidelines. It was the farming system with cultivation of plants or livestock breeding of different species in the same area under the common benefit for the highest efficiency relying on the co-existence of plants, animals, or environment, whether in the relationship between plant and plant, plant and animal, or animal and animal, with focus on each type of activity appropriate to the physical environment

(Department of Agriculture Extension, 2022). Although Smart Farming required a lot of investment and budget to manage and ensure that the output met the set target, the current Smart Farmers without prior background would require support from the government in terms of knowledge and budget to take care of the farmers in order to succeed in Smart Farming. In the past, the government through Ministry of Agriculture and Cooperatives formulated the Smart Farming Action Plan 2022-2023 based on Thailand 4.0 Policy and the 20-Year National Strategy. The government formulated the master plan on farming and the minor plan on smart farming under the strategy to increase competitiveness that Ministry of Agriculture and Cooperatives had the policy to drive smart farming with the intention to upgrade farmers' quality of life of Agriculture and Cooperatives (Ministry of Agriculture and Cooperatives, 2022).

Apart from various abilities, knowledge of farming from ancestors from one generation to the next with real practice was similar to knowledge from local wisdom which was knowledge from the development of science and wisdom of mankind. The knowledge and wisdom were the result of the process of continuously accumulated invention recognized by the general public as traditional knowledge specific in each area or geography which was the knowledge from skills, knowledge, and experience of community or local people to learn and solve the problems in their lives and handed down from one generation to the next (Natenapang Namjitthai, 2015).

Moreover, the production process of smart farming with standard and safety resulted in the output being certified with the G.A.P. standard. The G.A.P. is the system that prevents or reduces the risk of danger in agricultural goods and food. In terms of Good Agriculture Practices (G.A.P.) for plants, Department of Agriculture, Ministry of Agriculture and Cooperatives, is the agency responsible for inspection and certification of quality management system. G.A.P. for plants specifies the requirements, criteria, and method of assessment in line with international principles to serve as the standard to produce plants at the country's farm level, as well as prepares the manual of plant cultivation according to the G.A.P. principle for 169 varieties of major plants in Thailand such as fruits, durian, longan, dainty banana, pineapple, pomelo, mango, and orange; vegetables such as tomato, asparagus, kale, onion, cabbage, chili, cow-pea, green pea, Chinese cabbage, baby corn, onion, and

spring onion; flowering plant, fresh cut orchid, and Siam Tulip; other crops such as robusta coffee, cassava, rubber, etc. (Department of Agriculture Extension, 2022). The successful smart farming motivated the forming of farmer group to jointly practice Smart Farming in big plots. The activity was beneficial in terms of production process with negotiating power in costs, factors of production, and price negotiations instead of individual farming on one's own. The farming practice with each on one's own resulted in the fact that farming met with problems and constraints which would impact farmers' income and livelihood such as problems of costs such as seeds, factors of production, agricultural machine, agricultural labor force, lack of negotiating power in the production process, supply chain management, and transfer of knowledge and technology not yet readily accessible for the farmers (Department of Agriculture Extension, 2022).

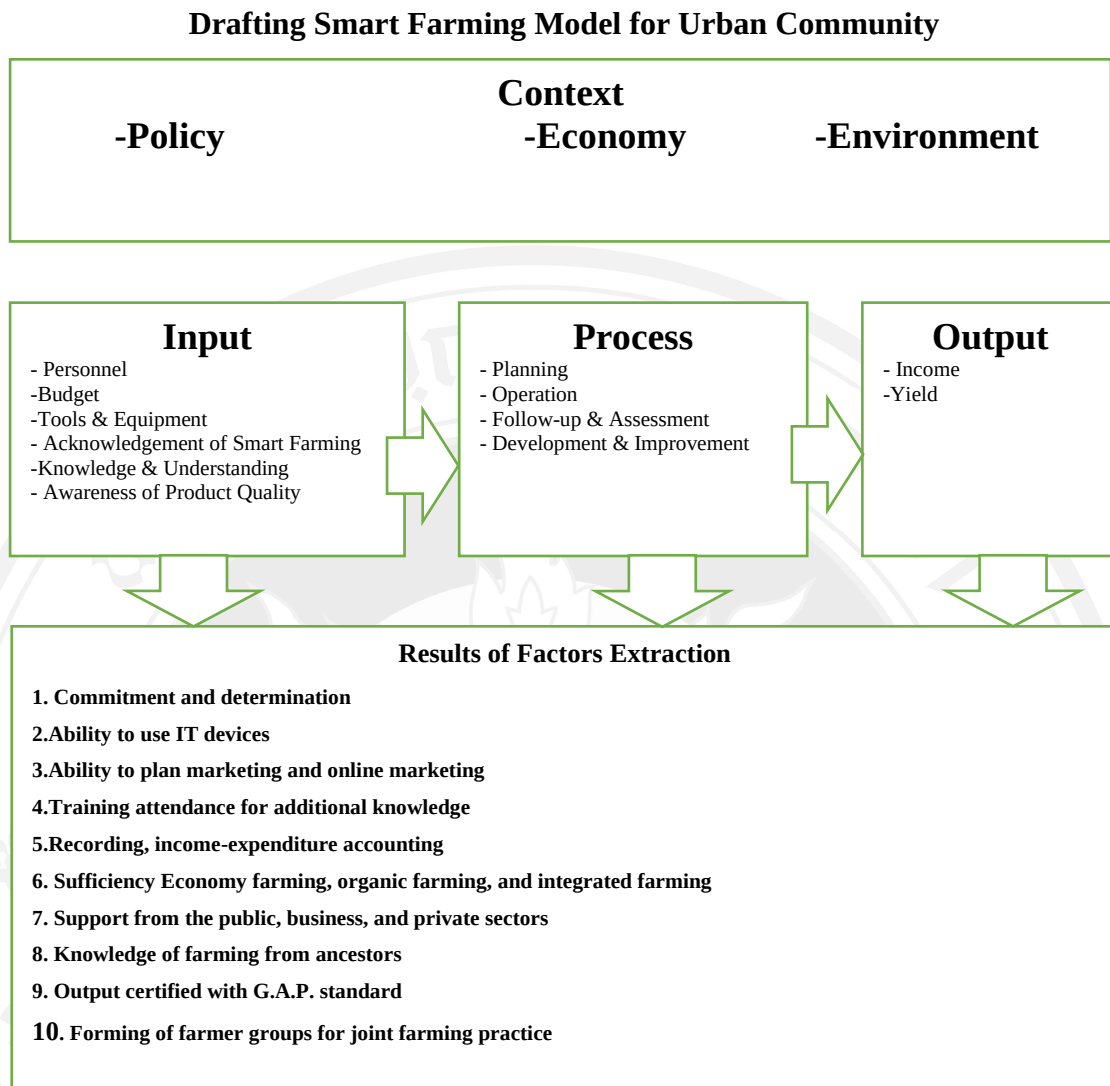


Figure 5.2 Drafting Smart Farming Prototypes for Urban Community

5.5.3 Model of Sustainable Smart Farming in Urban Community

The study findings revealed that in terms of factors of production namely personnel, budget, equipment, as well as acknowledgement of Smart Farming, knowledge and understanding, and awareness of product quality were in line with the theory and main concept of Smart Farm which was the use of electronic technology and computer, as well as IT technology to develop the whole supply chain, upgrading of output and agricultural goods, standard of goods, and reduced costs. The agricultural development was undertaken in 4 dimensions namely 1) Reduce costs 2) Increase production quality and standard of goods 3) Reduce risks from pests and

natural disasters and 4) Management and transfer of knowledge. As for the concept of Smart Farmer in the perspective of Ministry of Agriculture and Cooperatives, it meant the farmer with in-depth knowledge on farming profession, with the ability to plan and the consistent knowledge of demand, market, and production preparation, the ability to increase production efficiency and quickly solve problems through the analysis of the holistic information as component to assist in principle-based decision, as well as application of agricultural technology.

In the dimension of output, Smart Farmer would focus on production of agricultural goods with high quality, safe for consumers, and environmental-friendly. In the dimension of income, to move towards Smart Farmer, the farmer must have income at least at the same level or more than the minimum wage. These qualifications would promote the farmer who was Smart Farmer to depend on oneself in a sustainable manner (Ministry of Agriculture and Cooperatives, 2022). In terms of the operation process, planning, operation, monitoring and assessment, and development, they were in accordance with the principle, concept, and theory relevant to the farmer's learning Pitoon Thongchim (2015) which was the process when an individual changed behavior relatively permanent due to experience. The objective of learning was to reach the target as set in the vision, strategy, work process to ensure efficiency such as reduce mistakes, improve and develop the process to keep abreast with changing situations to ensure effectiveness, reduce costs, and create innovation such as develop and brainstorm thoughts, implement new ideas, develop people to ensure that they learn, that they were flexible at work, and were satisfied with work.

The income and output were consistent with the 20-Year Agriculture and Cooperative Strategy (2017-2036) Strategy 1 Strengthening farmers and farmer institutions with the following targets namely 1) Average income of farmers 390,000 baht/person 2) All farmers are Smart Farmers 3) Farmer institutions are strong at the levels of 1 and 2 for 95% with the following development guideline: 1) Strengthen farmers and farmer institutions, Smart Farmer, Smart Group, Smart Enterprise 2) Create pride and security in agricultural profession 3) Management of labor in agricultural sector by applying innovation and technology with the following indicators: 1) Income per capita of farmers (baht/person) 2) Percentage of farmers who are Smart Farmers per farmers at working age (aged between 18-64 years old) 3)

Percentage of farmer institution which is strong at the standard level 4) Number of farmers who are members of farmer institutions (average of 15 persons per group) and 5) Happiness indicator of farmers. In terms of impact, CSR, sustainability, environment, quality of life, and the Circular Economy, they were in accordance with the BCG economic model which was the concept of economic development in 3 models in parallel namely bio economy, circular economy, and green economy. Circular economy focuses on optimal resource use in 3 guidelines namely reuse, recycle or upcycle, and zero-waste by relying on the potential and strength of the country consisting of biodiversity and cultural diversity, utilization of science, technology, and innovation to create value added to drive the country towards sustainable economic growth, and widespread distribution of opportunity and prosperity.

**Smart Farming Model for Urban Community:
Education for Future Learning and Dissemination.
Using The CIPP-I Model Theoretical Framework**

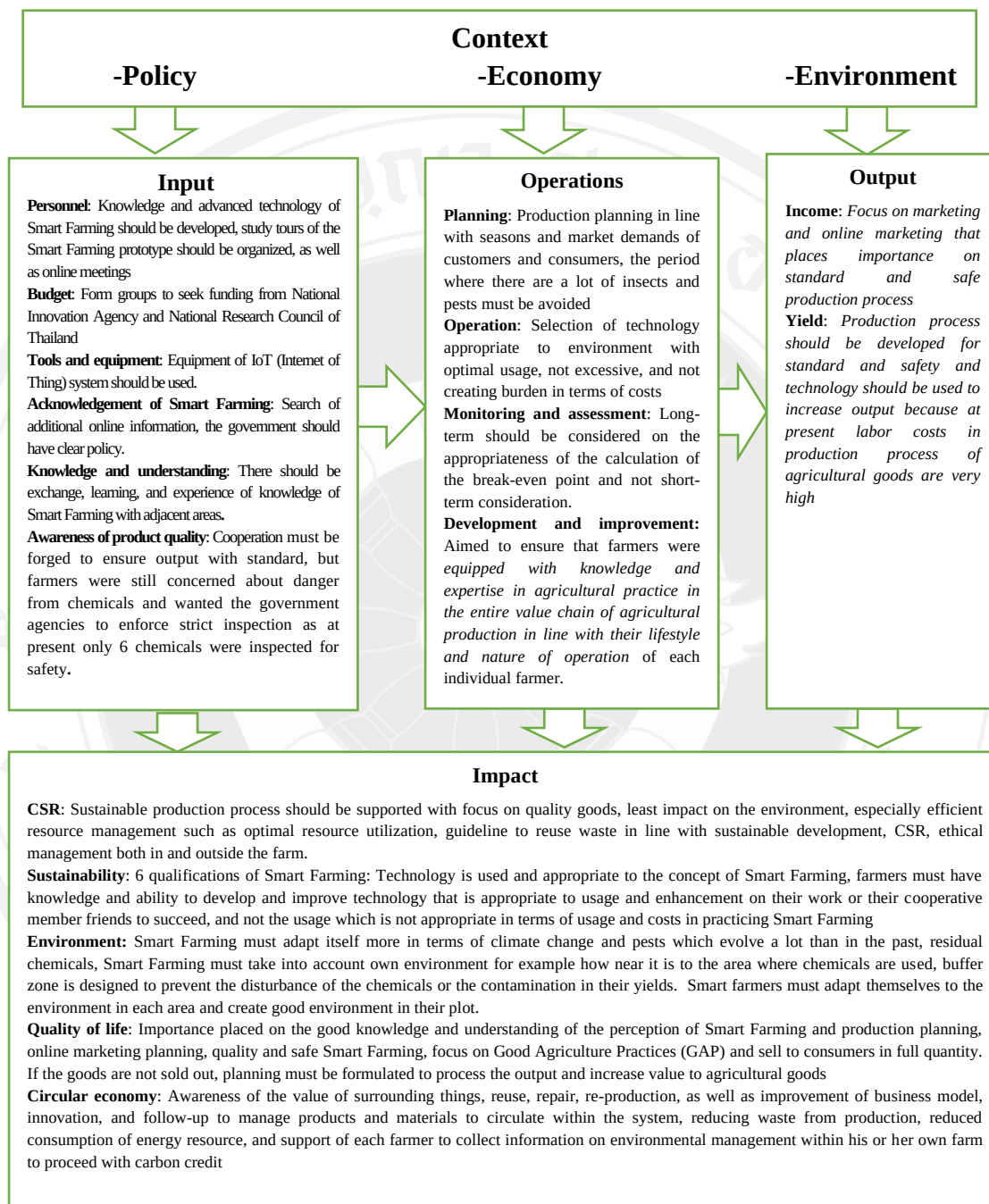


Figure 5.3 Smart Farming Model for Urban Community: Education for Future Learning and Dissemination. Using The CIPP-I Model Theoretical Framework

5.5.4 Smart Farming in Urban Community Differs from Conventional Smart Farming in Several Ways:

Scope of Practice: While Smart Farming in general focuses on the use of technology and information to improve agricultural processes in rural and remote areas, Smart Farming in urban community emphasizes the use of modern technologies and solutions for urban or community agriculture.

Scope of operation: Conventional farming usually takes place in large farms or farmland. While Smart Farming in urban areas uses limited urban areas for farming through the application of technology.

Land Use: Conventional Smart Farming emphasizes efficient crop production on large areas, while Urban Smart Farming maximizes the use of limited urban land using technology to increase productivity, quality and safety.

Concept Agriculture: Conventional Smart Farming focuses on technology-driven approaches such as optimum fertilizing and water management to increase productivity. In contrast, Smart Farming in urban community focuses on sustainability and resource conservation through practices such as garden recycling and circular economy.

In summary, Smart Farming in the Urban Community focuses on the use of modern technologies and innovative solutions for urban or community agriculture. The goal is to achieve effective results within a limited space, while promoting the sustainable use of resources.

5.5.5 Recommendations For Small Farmers with Small Plots of Land and Large Farmers with Large Plots of Land Who Want to Implement Smart Farming in Urban Community.

Smart Farming in urban community has many advantages for smallholder farmers with limited land, and large farmers with extensive land. This is valuable advice for farmers who want to implement Smart Farming techniques in urban environments.

Embrace Technology: No matter the size of your property Integrating technology into your farming practices is critical. Explore the use of sensors.

automatic watering system and Smart Farming applications that can monitor and increase efficiency in various fields of your crop production.

Efficient land use planning: for smallholder farmers with limited land to focus on the use of space for maximum benefit consider vertical farming hydroponics or a rooftop garden to increase your productivity within a small space. Large farmers should use precision farming techniques such as GPS-guided machines and variable rate applications to optimize productivity and reduce resource wastage.

Collect and analyze data: Use data collection and analysis tools to make informed decisions. Check the moisture level in the soil, weather pattern and crop growth data to adjust irrigation schedules, fertilizing and pest management strategies. Small farmers can use inexpensive sensors. While large farmers may invest in advanced data management systems.

Implement Sustainable Practices: Smart Farming Promotes Sustainability Include practices such as composting, organic fertilizer and integrated pest management to reduce dependency on input chemicals and minimize the impact on the environment. Use renewable energy sources whenever possible to power your farming operations.

Seek Knowledge and Collaboration: Stay up to-date on the latest smart farming techniques and developments by attending workshops, seminars and online courses. Engage with local agricultural extension services, research institutes and fellow farmers to share knowledge, experience and creativity.

Market your products: Build a direct connection with consumers by participating in farmers' markets. Focus on online marketing to gain clear insights into consumer needs and manage your production in line with market demands. This will solve the problem of oversupply and loss.

Applying these recommendations small farmers and large-scale farmers can effectively participate in Smart Farming within urban community. Smart Farming has the potential to increase productivity, reduce environmental impact and contribute to the development of sustainable urban farming practices.

5.5.6 Farmers Interested in Adaption Smart Farming Practices Should Consider Doing So Through Cooperatives, Community Enterprise or on Their Own Initiative.

Farmers interested in implementing Smart Farming practices can explore the following solutions:

Cooperatives: Joining or forming a cooperative allows farmers to pool their resources, knowledge and expertise. When working together they can invest in and implement Smart Farming technologies and practices. The co-operative is a platform for sharing costs, access to funding and share the benefits of the Smart Farming project community Enterprise: Participate in Smart Farming as a community enterprise that involves cooperation with other farmers. Local organization and community members by building partnerships and leveraging community support. Farmers have access to shared resources, knowledge and infrastructure. This approach fosters cooperation and promotes sustainable agriculture within the community.

Benefits of establishing a farmer group for large-scale farming together, especially in the context of smart farming by working together Smart farmers can use their collective bargaining power to negotiate favorable production costs and set better prices for their produce. This approach addresses the challenges faced by individual farmers who are often faced with high production costs, such as seeds, agricultural machinery, labor and a lack of bargaining power throughout the production process. Farmers often face limited access to supply chain management, knowledge transfer and technological advancement to overcome these limitations. Establishing farmer groups to farm together can help improve their income and livelihood, by helping them adopt smart farming practices, increase bargaining power and access to knowledge and technology more efficiently. The positive impact of promoting large-scale farming underscores the key success factors associated with this approach. One of the key factors is having strong leaders among farmers, with vision, determination and focus on the common interests of the group Cooperation between members and committee leaders is essential in driving the group's operations to be effective. Moreover, these groups should arise from the real needs and interests of the farmers themselves. Government agencies do not enforce Government policies that support such initiatives should be flexible and adapted to the local context. The

importance of empowering farmers and promoting participation and contextually appropriate approaches to agricultural development.

Individual initiatives: Farmers can also implement Smart Farming practices themselves by investing in relevant technologies. Seek knowledge through training programs or workshops and the use of innovative techniques. This approach requires self-motivation, willingness to learn and the ability to adapt to changing agricultural practices. No matter which way you choose Farmers interested in Smart Farming should consider the following steps:

1) Educate yourself: Get educated about Smart Farming technology, practices, and the benefits of Smart Farming technology. Stay up to-date on the latest advancements and best practices through training programs, workshops, online resources, and interactions with experts in the field.

2) Feasibility Assessment: Assess the feasibility of implementing Smart Farming practices on your farm. Consider factors such as available resources, farm size, budget, market demand and the appropriateness of the technology for your particular context.

3) Plan and Strategize: Develop a comprehensive plan that includes specific goals, timelines, and steps required to implement Smart Farming practices. Consider factors such as crop selection, Data Management Irrigation System Pest Control and the utilization of resources for maximum benefit

4) Seek support: Cooperate with agricultural extension services, research institutes and technology providers. They can advise, support and access funding opportunities for implementing Smart Farming initiatives.

5) Start Small and Scale Up: Start with piloting Smart Farming practices at a smaller scale to assess their effectiveness and feasibility. Learn from experience and gradually Expand the adaption of Smart Farming technologies and techniques based on available results and resources.

6) Monitoring and Evaluation: Continuously monitoring and evaluating your Smart Farming performance, collecting data, analyzing results and make adjustments as needed to increase productivity resource efficiency and sustainability.

By considering these guidelines and implementing a systematic implementation plan, Farmers can successfully implement Smart Farming practices and leverage advanced technology in their agricultural operations.

5.6 Recommendations

The presentation of the model of sustainable Smart Farming in urban community using the conceptual framework of the model of Smart Farming from the field trips, the study results could be summarized and recommended as follows:

5.6.1 Recommendations For the Research to be Used in Terms of Practice.

According to the results of Smart Farming, most of them still lack knowledge in the production process and marketing planning and online marketing. Therefore, the government should take the following actions:

- 1) Seek Collaboration: Build partnerships with local communities, businesses, academic networks, and governments to put ideas and research into action.
- 2) Promote the use of technology in agriculture: Promote the use of technology in smart farming, such as smart farm systems. sensor technology and Internet of Things connectivity to increase production efficiency and sustainable resource management.
- 3) Education and Knowledge Building Organize a project to educate and train on Smart Agriculture in the community to increase knowledge and skills of farmers and communities in using technology and agricultural innovation.
- 4) Policy advocacy: Implement policies that promote the utilization of smart agriculture research and education. Including support for the introduction of new technologies. Promotion of agricultural innovation and policy formulation at community and regional levels.
- 5) Analysis and Evaluation: Conduct regular analysis and evaluation to monitor and improve the conduct of research and education on smart agriculture in the community. To ensure continuous improvement and development

6) The application of research and education on urban smart agriculture will increase agricultural productivity. Reduce the use of environmental resources improve product quality and generate income for the farming community. It also provides opportunities for the development of technology and agricultural innovation in the community.

5.6.2 Recommendations For the Research to be Used in Terms of Policy.

According to the study, the key policies necessary to support successful Smart Farming in urban community include the following:

1) Promoting Smart Farming Policies: Governments should promote policies that support the use of technology and innovation in smart farming. Emphasis is placed on the development of suitable and cost-effective technologies for farmers and urban communities.

2) Creating policies to support the use of technology: Develop policies that support and promote the use of smart farming technology in urban communities. Providing incentives and financial support to improve urban agricultural production.

3) Foster collaboration: Build collaboration between research institutes. An organization specializing in smart agriculture, farmers and urban communities. To ensure that research and study results are carried out effectively.

4) Information and education: Provide support to create and share information related to smart agriculture in urban areas. as well as training and education programs for farmers and relevant stakeholders to enhance their knowledge and skills in using smart farming technologies.

5) Resource Creation: Smart Farming Technology Research and Development Center was established. provide technical support And develop human resources to be a source of information and expertise in the use of smart farming technology in urban communities.

6) Establishing standards and regulatory mechanisms: Establish appropriate standards and regulatory mechanisms for the application of smart farming

technology in urban areas. To ensure proper and efficient use of these technologies in sustainable urban agriculture.

7) Policy implementation of research and education on smart urban agriculture requires public-private partnerships and the creation of projects that promote the sustainable use of smart farming technologies in urban communities.

5.6.3 Recommendations for Future Research

To ensure that research can be utilized sustainably for future benefits. Consider the following helpful tips:

1) Promoting Smart Farming Innovation: Promote and promote smart farming innovation in urban communities through research grants and project design. It focuses on developing technologies suitable for urban environments, such as small distributed cultivation systems and automated harvesting technologies.

2) Build a learning and knowledge sharing system: Build a learning and knowledge sharing system for urban smart agriculture, as well as organizing training programs and facilitating the exchange of knowledge and experiences between farmers and communities that have adopted the smart farming model.

3) Promotion of commercial utilization: Promote the commercial use of smart farming models in urban commercial farming by providing funding and administrative support. Create market opportunities and facilitate access to business resources, for example through the development of an online platform for efficient business operations.

4) Creating policies to promote smart farming: Develop policies that promote the adoption of smart farming models in urban areas, by providing relevant information about the technology

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APPENDIX A

Research Instrument Consistency Index (IOC) Assessment Form

For experts to consider, evaluate and give advice.

Model for smart farming (Smart Farming) in urban communities

Assessor.....position.....

Appraisal Date.....

origin and concept of education

The study of Smart Farming in urban communities will mainly study Smart Farming in urban areas by selecting farmers who are qualified as Smart Farming according to the criteria of the Ministry of Agriculture and Cooperatives (2013), using the conceptual framework of Smart Farming. This study will benefit farmers and those who are interested in Smart Farming in urban areas as well as creating new knowledge in terms of useful models for Smart Farming in urban communities. can achieve the goals set It is expected that relevant agencies can apply the study results to smart farming in urban communities efficiently.

Objectives of the study

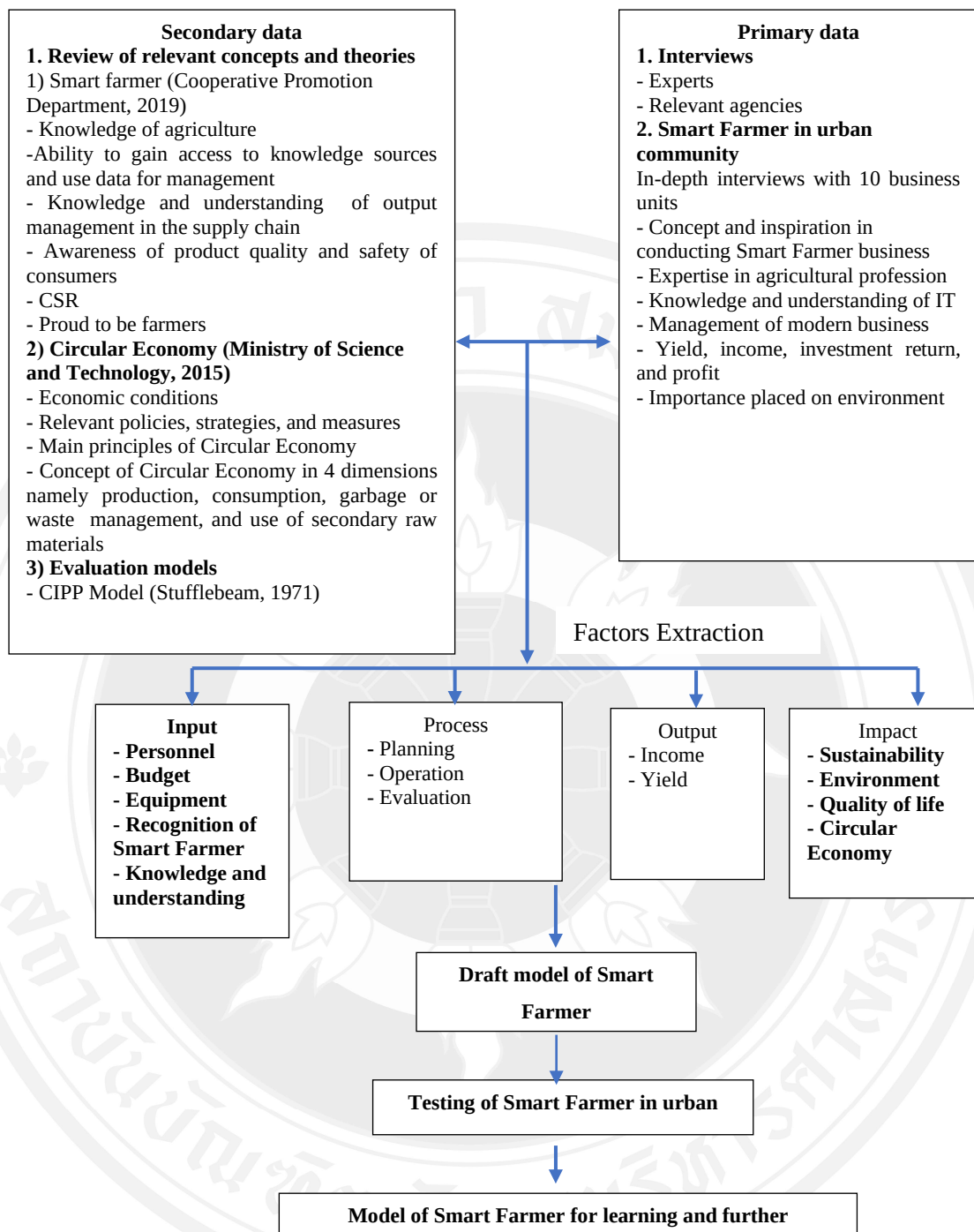
1. To study Smart Farming in urban communities, including studying problems and obstacles.
2. To analyze the factors affecting the success of Smart Farming in urban communities.
3. To present a model of sustainable Smart Farming of urban agriculture.

Explanation

Please check the question and mark $\checkmark$ in the box that corresponds to your opinion. The criteria for consideration are as follows: Mark $\checkmark$ in the +1 box when you are sure that the question is consistent. Mark $\checkmark$ in the box 0 if you are not sure whether the question is consistent. Mark $\checkmark$ in the -1 box when you are sure that the question does not correspond.

In case you have any comments or suggestions for improving each question Please write your comments or suggestions in the feedback box. be a grateful.

Conceptual Framework



Instrument Quality Check (IOC)

Questions for Smart Officer

No.	Questions	Expert Opinion Scores			Average Scores of IOC
Part 1 Management Dimension Operations		-1	0	1	
1.	How much knowledge and understanding do your personnel in your organization have about Smart Farming and are there any training sessions on smart agriculture? If so, how often are meetings held?	0	2	8	0.80
2.	Does your organization have a smart farming plan/project and is the budget allocated according to the policy plan for Smart Farming in urban communities adequate?	0	3	7	0.70
3.	Your organization has policies/guidelines/measures regarding Smart Farming. How does your organization support Smart Farming? In urban communities or not? Since which year has it been in operation? Is it continuously implemented?	0	0	10	1.00
Part 2 Implementation of the Effectiveness Dimension					
4.	Is Smart Farming suitable for the urban environment?	0	2	8	0.80
5.	Actions are monitored Smart Farming in Urban Communities and Is it Appraised? How?	0	1	9	0.90
6.	Is the number of farmers participating in smart farming increasing? Is technology	0	3	7	0.70

No.	Questions	Expert Opinion Scores			Average Scores of IOC
	increasingly being adopted?				
Part 3 Operations in Environmental Dimensions					
7.	Is there environmental management for Smart Farming in urban communities? without causing the destruction of the human cycle. Economy, Society, Resources and Environment.	0	1	9	0.90
8.	Smart Farming in urban communities has an impact on ecosystems, climates, etc. Tone, sound, garbage? How?	0	0	10	1.00
9.	Is there a good quality of life management for Smart Farmer in urban communities? How?	1	1	8	0.70
Part 4 Operations in the Circular Economy Dimension					
10.	Smart Farming in Urban Communities Is there a circular economy within the community? How?	0	0	10	1.00
11.	Your agency's operations have problems and obstacles in Smart Farming in urban communities.	1	5	5	0.40
12.	Measures to solve problems and improve Smart Farming in urban communities.	2	3	5	0.30
Part 5 Recommendations to promote sustainable smart farming in urban communities					
13.	13. Additional suggestions.	0	0	10	1.00

Instrument Quality Check (IOC)

Questions for Entrepreneurs

No.	Questions	Expert Opinion Scores			Average Scores of IOC
Part 1 Management Dimension Operations		-1	0	1	
1.	How much knowledge and understanding do farm personnel have about Smart Farming?	0	1	9	0.90
2.	Budget allocated according to the policy plan for Smart Farming in urban communities Is your farm adequate?	0	1	9	0.90
3.	Your farm has policies/guidelines/measures regarding Smart Farming. How are you doing in urban areas?	0	0	10	1.00
Part 2 Implementation of the Effectiveness Dimension					
4.	Does your farm support Smart Farming in urban areas? And is it suitable for the urban environment? How's that?	0	2	8	0.80
5.	Your farm is tracked Smart Farming in Urban Communities and Is it Appraised? How?	0	0	10	1.00
6.	How productive and efficient is your farm in Smart Farming in urban areas?	1	1	8	0.70
Part 3 Operations in Environmental Dimensions					
7.	Does your farm have environmental management for Smart Farming in urban areas? without causing the destruction of the human cycle. Economy, Society, Resources and Environment.	0	0	10	1.00
8.	Your farm has smart farming in urban areas, affecting the ecosystem, climate, etc. Tone, sound, garbage? How?	0	1	9	0.90
9.	Does your farm have a good quality of life	1	2	7	0.60

No.	Questions	Expert Opinion Scores			Average Scores of IOC
	management for Smart Farming in urban areas? How?				
Part 4 Operations in the Circular Economy Dimension					
10.	Smart Farming in Urban Communities Is there a circular economy within the community? How ?	0	0	10	1.00
11.	What are the problems and obstacles of Smart Farming in urban areas?	1	2	7	0.60
12.	Your farm has measures to solve problems and improve Smart Farming in urban areas.	1	2	7	0.60
Part 5 Recommendations to promote sustainable smart farming in urban communities					
13.	Additional suggestions.	0	0	10	1.00

Note: 1 = Congruent

0 = Not Certain

-1 = Not Congruent



APPENDIX B

Interview Form for Entrepreneurs

Name of establishment.....

Name of interviewed person..... Position.....

Location..... Date of interview.....

1. How much do employees know and understand Smart Farmer agricultural practice?

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2. Is budget for Smart Farmer agricultural practice in urban community sufficient?

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3. Are the equipment and tools for Smart Farmer agricultural practice in urban community sufficient?

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4. Does the entrepreneur acknowledge about Smart Farmer from learning and practice to be able to use it in the entrepreneur's own farm? How?

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5. Does the entrepreneur have knowledge and understanding of Smart Farmer agricultural practice and can the entrepreneur transfer the knowledge and understanding to the interested persons?

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6. Is there the process of Smart Farmer agricultural practice in urban community? How?

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7. Is there the process of conducting activities on Smart Farmer agricultural practice in urban community? How? Is it appropriate to the environment of urban community? How?

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8. Are there follow-up and evaluation of Smart Farmer agricultural practice in urban community? How?

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9. What is the income of Smart Farmer agricultural practice in urban community?

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10. What is the output from Smart Farmer agricultural practice in urban community?

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11. Is there environmental management for Smart Farmer agricultural practice in urban community without destroying the human, economic, social, resources, and environmental cycles?

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12. Does Smart Farmer agricultural practice in urban community have impact on ecosystem, air, water, noise, and waste? How?

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13. Is there management of good quality of life from Smart Farmer agricultural practice in urban community? How?

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14. Does Smart Farmer agricultural practice in urban community lead to Circular Economy in the community? How?

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15. Additional recommendations

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APPENDIX C

Interview Form for Experts and Relevant Agencies

Name of agency.....

Name of interviewed person..... Position.....

Location..... Date of interview.....

1. Do the employees in the agency have knowledge and understanding of Smart Farmer agricultural practice? How much do they know and understand the issue?

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2. Is the budget sufficiently allocated according to the policy and plan for Smart Farmer agricultural practice in urban community?

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3. What policies/guidelines/measures on Smart Farmer agricultural practice in urban community does your agency formulate?

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4. Does your agency support Smart Farmer agricultural practice in urban community?
How? Is the support appropriate to the environment of the urban community? How?

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5. Are there follow-up and evaluation of Smart Farmer agricultural practice in urban community? How?

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6. How effective and efficient is Smart Farmer agricultural practice in urban community?

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7. Is there environmental management for Smart Farmer agricultural practice in urban community without destroying the human, economic, social, resource, and environmental cycles? How?

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8. Does Smart Farmer agricultural practice in urban community have impact on ecosystem, air, water, noise, and waste? How?

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9. Is there management of good quality of life from Smart Farmer agricultural practice in urban community? How?

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10. Does Smart Farmer agricultural practice in urban community lead to Circular Economy in the community? How?

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11. Do you have problems and obstacles from Smart Farmer agricultural practice in urban community?

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12. Measures to solve problems and improve Smart Farmer agricultural practice in urban community

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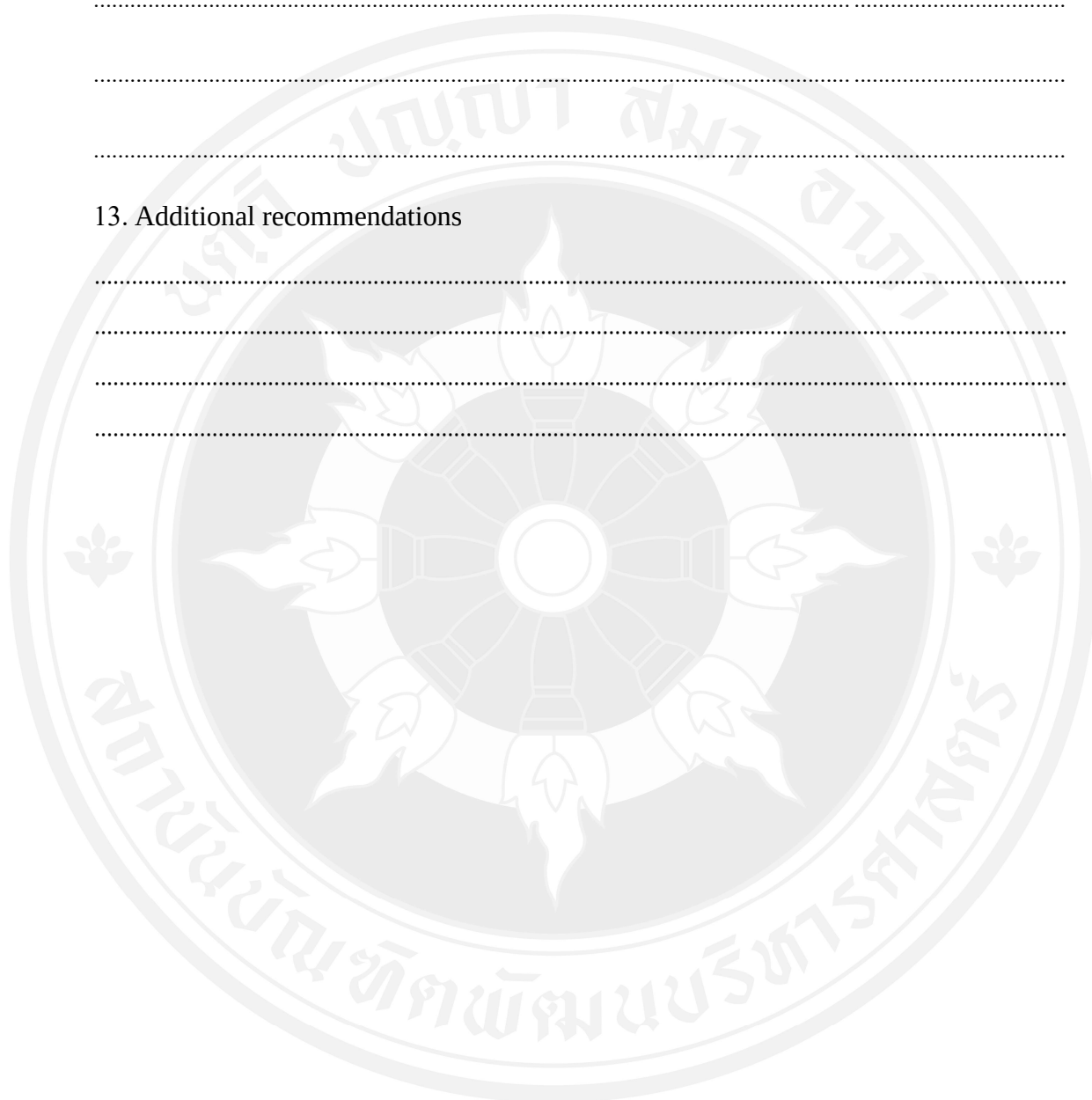
13. Additional recommendations

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BIOGRAPHY

Name-Surname	Ekaluck Kanchananiyom
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Experience	Ekalak Sala Banmai Klang Suan Co., Ltd. Position Managing Director No. 6 Intersection 5, Soi Ramkhamhaeng 187/1, Ramkhamhaeng Road Min Buri, Min Buri Distric, Bangkok 10510

