SATI (SMARTER AGRICULTURE THAI INITIATIVE):
A SMARTER ORGANIC FARMING MODEL
FOR THAI FARMERS

BY

MISS KANPHATTASINEE SISANG

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE
DESIGN, BUSINESS AND TECHNOLOGY MANAGEMENT
FACULTY OF ARCHITECTURE AND PLANNING
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Chairman _____
(Jitiporn Wongwatcharapaiboon, Ph.D.)

Member and Advisor _____
(Isaac Jamieson, Ph.D.)

Member _____
(Rawisara Chulerk, Ph.D.)

Dean _____
(Assistant Professor Asan Suwanarit)

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Author	Miss Kanphattasinee Sisang
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Thesis Advisor	Isaac Jamieson, Ph.D.
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ABSTRACT

Agriculture has played a significant role as a major driver of the Thai economy for many generations. Thailand 4.0 and its Agriculture 4.0 aims to proactively increase: the country's economic prosperity, its social well-being, raising its human values and educational provisions, and enhancing its environmental protection.

With that in mind, the present research then was carried out through identifying a number of existing and future risks that Thai farmers and the communities that they live in face before developing the "Smarter Agriculture Thai Initiative (SATI)", a practical and innovative model in which benefits and risks are critically assessed in order to help improve the wellbeing of farmers and their families.

The proposed SATI model is created in this research by merging hard-earned wisdom and insights with cutting-edge knowledge from literature, critically analysing the existing successful agricultural business models and combining their key success and studying their lessons learned together with qualitative and quantitative approaches undertaken through in-depth interviews and online survey. Additionally, some of measure proposed in this model help address climate change challenges in relation to the carbon emissions in farming activities.

The findings of this research indicate the barriers and challenges that exist with regard to adopting smarter organic approaches and the motivational factors that can encourage its more widespread adoption. The outcome is the SATI model which would enable, after an initial period of investment, the creation of an inclusive self-funding organic growth initiative that actively shares specialist and intergenerational knowledge and skills, while combining together aspects of smart farming, organic farming, and agroforestry with cluster growth and the appropriate adoption of bio-friendly high-tech and low-tech technologies and approaches to revitalise Thai agriculture and rural communities.

The ethically-driven SATI model is more inclusive than standard smart farming solutions which typically focus on younger generation farmers, and is designed and developed on the three pillars of sustainability: People, Planet and Profit. Furthermore, the SATI model suggests how through the selective use of appropriate technological and development management strategies, rural communities could become revitalised as sustainable bio-friendly growth hubs in their own right.

Keywords: Smart farmer, Community-based, Agroforestry, Poverty-reduction, Bio-friendly agriculture

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Miss Kanphattasinee Sisang

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CHAPTER 1
INTRODUCTION

1.1 Research background

Agriculture has played a significant role as a major driver of the economy of the Thai nation for many generations, with high levels of produce provision and agricultural exports that have driven its success internationally which have enhanced its development, and contributed to its financial growth and long-term sustainability.

In order to move forward in Thailand 4.0 and its Agriculture 4.0, it is important for the driving forces of the economy, particularly those within the agricultural industry, to know how to better deal with and handle the challenges and opportunities they face and better develop their ability to succeed. In terms of water management that affect the ecosystem and water quality for agriculture and consumption, promote crop production in agriculture system and security farming, promote knowledge support as market and organic farming (bio-fertilizer and compost) to reduce production costs, increase channel for farmers to solve problem of falling or oversupply prices and develop them for being a smart farmer.

Moreover, developing the rice processing, packaging and distribution, raising livestock and fishery to increase the production of aquatic animals sufficient for consumption and creating additional income for farmers at all levels. In addition, with the disruptive technology, agricultural management requires more quality information to create the Big data and Precision Farming, and establishment agri-technology and innovation center (AIC) in agriculture today.

An aspect that Lertdechdecha (2017) points out is that in the preparation and development of Thai farmers to support smart modern agriculture, they must become: more knowledgeable about production systems; have the ability to be analytical; manage production and marketing; and have greater concern about the quality of their produce and the safety of consumers, society and environment. Those are very high requirements.

During the year 2016, the government launched a policy to support agriculture which expected to complement which is education (Wittayasin, S., 2017) and as Puncreobutr (2017) assumed that it must be rethink and deliver the knowledge to the society and increase the awareness for achievement.

Smart farming is already redefining the essence of what needs to be done to empower those who seek accurate knowledge and know-how on how to practice more efficient agriculture. If pursued and developed correctly, it will enable farmers to have greater resilience to the effects of risks. It can help them perform better with regard to demand and supply planning for present and future market situations, have the ability to be more self-reliant, increase production efficiency and be better equipped to solve sudden unexpected problems. In addition, smart farming can enable farmers to better analyse and understand data that can form an important component of their decision-making based on principles and reasoning. It can also be applied in technology and innovation as an important aid in increasing productivity and increasing the ability to position of market competition in order to increase trade value and distribution of farmers' income thoroughly.

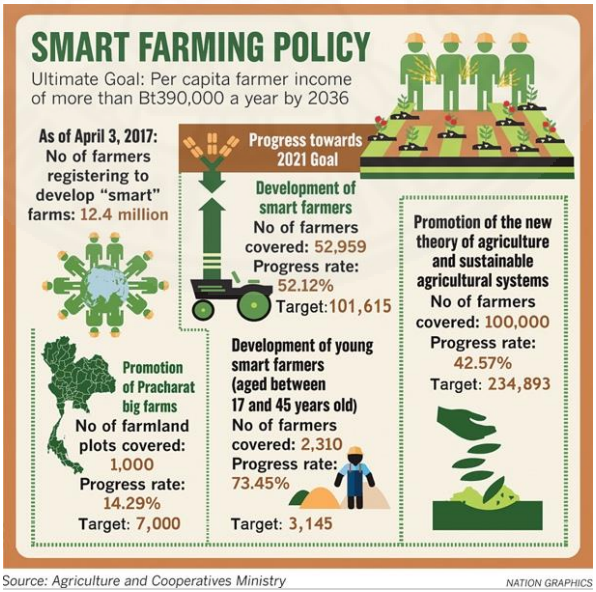


Figure 1.1 Thailand's smart farming policy

Source: Saengpassa, (2017).

For increasing the future prospects and resilience of Thailand's agricultural sector over the next 10 years and beyond, collaboration, cooperation and opportunities within The Association of Southeast Asian Nations (ASEAN) may lead to market expansion, increased production factors and the opportunity for those within the agriculture community to make more income. There are many opportunities for economic development and international cooperation that can be created through thinking smartly and innovatively, and bringing communities together to address the challenges that are faced. Smarter organic farming presents one of these opportunities, particularly, it is proposed, if it is combined with innovation, traditional knowledge, measures to increase biodiversity, measures to improve resilience, and techniques to enable smoother adaptation to climatic changes.

It is proposed in this present thesis that the best way forward actually lies in part in the generation of a 'middle way', adding extra value, bringing together the best of traditional knowledge and established and emerging organic practices, both from Thailand and abroad, with new bio-friendly smart approaches to increase agricultural efficiency, reduce risks and create multiple layered benefits to all, including helping regain agriculture's previous share of the nation's GDP, and helping create new agricultural initiatives to address climate change and other risks we face, such as the current COVID-19 pandemic.

This present research has striven to identify a number of existing and future risks that Thai farmers and farming communities face. The Smarter Agriculture Thai Initiative (SATI) is a transformative sustainable organic farming model for Thai farmers developed as a practical and innovative model in which benefits and risks are critically assessed and reviewed in order to help improve the wellbeing of farmers and their families and better anticipate their future needs. Additionally, a number of the measures proposed and developed for this model also help address climate change challenges.

This ethically-driven model is designed and developed on the three pillars of sustainability: People, Planet and Profit. In this study, building knowledge, increasing empathy and wellbeing are the main focus for the first pillar, with measures additionally being taken to investigate how to create more inclusive biologically-

friendly environments that also enhance community cohesion and growth; preserving and enhancing the natural environment is the second. Here the intention is to seek to do no harm and to create farming patterns and use of techniques and technologies in ways that help nature too; and optimising long-term profitability is the third.

As part of the strategies for the third pillar it also looks at low cost smarter ways that can be adopted to help this be achieved. Hence, this research seeks to investigate, develop and promote bio- and environmentally-friendly solutions and best practice which better address the risks that farmers and other members of the rural community often face and helps them to face a more certain future even in times of great uncertainty.

It is proposed that in order to help farmers develop more cost-effective solutions and better adapt to climate change, both high- and low-technologies can be applied in running their everyday businesses. The proposed SATI model is more inclusive than standard smart farming solutions and strategies which typically focus predominantly on younger generation farmers. It combines the hard-earned wisdom and insights of its stakeholders, and the lessons provided by history, with cutting-edge knowledge. It also allows the blending of different specialisms such as smart farming, organic farming, and agroforestry.

Furthermore, it takes into account the findings from related industries, and the findings of the latest scientific research particularly that related to farming, health and the environment with regard to best practice measures that can be adopted. Moreover, it encourages all members of Thai farming communities to have a voice and be able to contribute their ideas and suggestions regardless of their prowess with modern technology. The model allows solutions to be tailored to their abilities and knowledge disseminated accordingly. Given that the majority of the farming community is elderly, this approach appears particularly appropriate.

It is proposed that through combining old wisdom and new knowledge together with the correct selection of both high and low technologies, even better, more revolutionary and more inclusive solutions can be more rapidly found. Examples of this are discussed. Furthermore, the SATI model suggests how through the selective use of appropriate technology and development management strategies, and through

the increased adoption and promotion of measures to help address climate change, rural communities could become revitalised as growth hubs in their own right and further increase their importance in the future economy of Thailand. It is additionally proposed that suitably adapted versions of this model could be used elsewhere as well.

Merging the wisdom of old knowledge with new, flexibility of thought, developing best practice, and increasing stakeholder buy-in and ownership of the solutions being developed, presents one of the best ways to achieve resilient, high quality sustainable organic change. It is also proposed that new models for smarter farming can be developed to fight many of the challenges that we face from climate change, including the need to transform into a climate-neutral or climate-beneficial system.

It is also important to realise that many of the smart options that can be taken to achieve this aim need not actually be high-tech, a factor that may further increase 'buy-in' for smart approaches by farmers over 50 years of age. Some farmers, particularly those belonging to the older generation, can often provide some very valuable insights into how to approach the challenges we face. As an example, with regards to the maintenance and harvesting of fruit trees, mention is made of the technique adopted by an organic farmer in Nakhon Ratchasima Province: all the durian trees at his farm are specially trimmed for particular ease of crop harvesting so there is not even the need for a ladder to collect the fruit (Auamnuaychai, N., 2019). Such knowledge can also be readily shared with farmers elsewhere through adopting a smart approach.

Additionally, the way to make farmers a sustainable and balanced living with nature, it may help indicate the ability for competition with others, encourage the generation of important solutions for driving the national economy, and help increase resource sustainability. In addition to cultural diversity, Thailand already has huge biological diversity with regards to flora and fauna. Additionally, many organizations are undertaking work to protect, safeguard and use traditional agricultural knowledge, including being involved in the reintroduction of indigenous crops and ways of farming to help address the challenges of climate change as this "increases the likelihood that

some of the species present will be able to cope as conditions change" (FAO, 2016, p. 59). Adopting a smarter organic approach and undertaking organic agroforestry can greatly help with regards to increasing poverty eradication and improving educational standards within farming communities. It can also help the country better addressing the risks of climate change and improve its national food security. Furthermore, adopting a holistic approach to this concept that enables the involvement and enrichment of whole communities, and the environments they exist in, using biologically friendly concepts and technologies that help address the challenges we all face will create many additional net benefits. In order to undertake such measures, it is important to be able to provide an indication of the benefits they can create, and also to gain a realistic impression of the kinds of barriers that may exist to such achievements and how they may be successfully overcome.

1.2 Research question

The research question that has been developed for this work is: "How can farmers gain and generate the knowledge necessary to create smarter, more resilient, organic farming and agroforestry initiatives through an inclusive approach that blends the best of old and new knowledge?"

The model that is being proposed brings together and combines knowledge on a wide variety of different farming types and approaches that can be taken to help optimise returns, improve lives and reduce risk.

1.3 Research objectives

The research objectives of this work are as follows: to investigate the existing barriers, future risks and opportunities that Thai farmers face with regard to their profession; to understand and undertake observation of relevant areas; and to create a sustainable guideline model initiative to enable them to create long-term beneficial growth, change and wellbeing for themselves, their families and their communities.

1.4 Research Framework

The research framework adopted in this present research covers the challenges that exist that have been brought to the attention of the author, which has led to the development of the research question investigated, and the development of the proposed business model and blueprint for SATI (Figure 1.2).

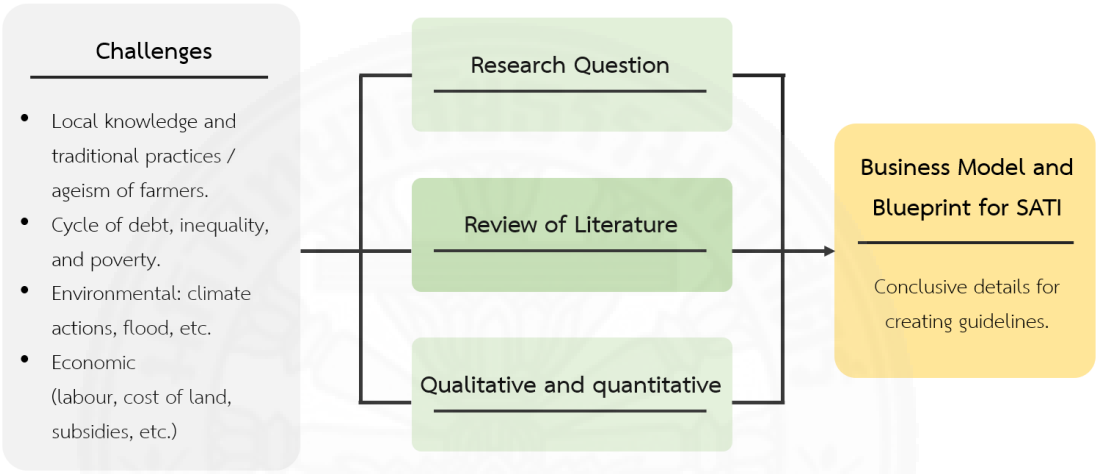


Figure 1.2 Research framework

1.5 Scope of the research

The scope of this work is limited to the study of the obstacles, challenges and opportunities for developing and refining the proposed SATI Model and the concept of creating and refining a sustainable business model for Thai farmers to generate long-term beneficial change for themselves and others at micro and macro level.

CHAPTER 2
LITERATURE REVIEW

The research undertaken as part of this study has identified and critically investigated a number of existing and potential future risks being faced by Thai farmers. It reviews and develops a wide variety of theories and concepts, including His Majesty King Bhumibol Adulyadej's Sufficiency Economy Philosophy, related to finding ways to develops theories and refine the proposed "SATI (Smarter Agriculture Thai Initiative): A Smarter Organic Farming Model for Thai Farmers" to help innovatively improve the wellbeing of Thai farmers, their families and the communities they live in whilst reducing the risks they face. A number of the measures and strategies have been assessed for this transformative model to help sustainably improve their lives and help provide them with greater financial security whilst additionally helping address a number of climate change issues.

A wide variety of sources have been consulted in the preparation and development of this chapter to develop a greater understanding of the complex issues that are faced, to create knowledge and guides for the research, and gain a detailed understanding of the challenges that exist and how they might best be addressed. These have been obtained through: peer-reviewed journals and articles, official reports, on-line and offline research and follow up investigative work. This chapter is comprised of the following sections:

2.1 Research challenges

2.1.1 The journey to Thailand 4.0

The new Thailand 4.0 economic model has been adopted in order to help the country out of the poor-quality education and inequality trap (Puncreobutr, V., 2017). From the government's perspective, Thailand has undergone through three historical phases of economic development and industry leaps.

Thailand has developed an effective policy response through proactively developing Thailand 4.0, an economic model designed to unlock the

country from several challenges and transform its economic structure into that of a Value-Based Economy. There has been some interesting research on the Fourth Industrial Revolution shows how the beginning of model impacting all disciplines before the latest revolution in moving towards science and technology, creative thinking and innovation. There has been promoting economic development in different industries and raise the value-added product (Jones and Pimdee, 2017).

Starting from "Thailand 1.0", the first period of Agriculture economic model focuses on investment in this sector and using natural resources by planting crops and raising animals which mainly our fundamental strengths of the country to increased productivity for agriculture, and mainly generate their income by farmland and livestock.

During the era of economy 2.0 was emphasised on light industries (Puncreobutr, 2017; TIR, 2017; Jones & Pimdee, 2017) which emphasised on natural resources, low labour cost for increased efficiency and system development with mass production that turn into finished good for production and manufacturing such as manufacture cloth, textiles, garments, accessories and food processing. It helps supported domestic manufactures and developed the low-income to middle-income nation.

And through to advanced industry of 3.0 has been more complex industries that intensive on production, investment and imported technologies (electrical components and automobiles for exports) from foreign countries which enable a better performance and exchanging the information. In this era, Thailand has experienced the super transcend, the middle-income trap (Wittayasin, 2017), Inequality and unbalanced development.

Afterwards the government announced the strategy of Thailand 4.0 which "focused on turning Thailand's labor force into knowledge workers" (Jones & Pimdee, 2017). Additionally, the Ministry of Agriculture and Cooperatives intends to drive the policy towards creating a more stable and sustainable for future in order to help solve the problem of farmers' quality of life and enable them to handle any situation that may directly affect farmers and citizens. The four main objectives of

Thailand 4.0 are: Economic Prosperity; Social Well-being; Raising Human Values; and Environmental Protection. These are all covered within the SATI model.

2.1.2 Smallholder and farm size

Over 30% of Thailand's land area is presently used for agricultural purposes, and it currently provides employment for around 35% of Thailand's workforce. The majority of the Thai farmers are smallholders (FAO, 2018, p.1; Singhapreecha, C., 2014; Attavanich et al., 2019). Many of these smallholders are in debt, and a large number of them are landless, even though they often wish to establish ownership rights for the land they work on. Enabling farmers to obtain full ownership of the land they work on will empower them. It can provide incentive for them to invest in, and look for, ways to improve their productivity and production efficiency, including how they produce their crops and which types of crops and added value propositions they should focus on.

Unexpected changes can impact the economy and have knock-on effects on small-scale farmers. The agricultural sector has been facing both environmental scarcities, considering several changes in the labour force broadly reflect in structure change in economy and it have mainly resulted in its declining proportion of the nation's GDP, due to farmland confined to a limited area and give the rapidly growth in the non-agricultural sector. Moreover, the economic changes have created serious problems as related to scale of production issues and impacts on small-scale farmers who struggle to survive to cope with them.

In the case of agriculture in Thailand, the average farm size often varies between areas according to its location, difference in soil types, and technological change, all of which can impact farmers' income and production efficiency on their farms. It has been shown that there is a direct relationship between the size of a farm and how efficiently it performs, with smaller farm sizes providing reduced net income in Thailand during 1986/87 (Wattanutchariya and Jitsanguan, (n.d.)) as shown in Table 2.1.

Table 2.1 Average farm income and farm expenses by farm size

Unit: US$/farm

Item	Farm size (ha)									
	<0.32	0.32–1.60	1.60–3.20	3.20–4.80	4.80–6.40	6.40–8.00	8.00–9.60	9.60–11.20	>11.20	Average
Cash farm income	522.35	605.88	656.47	702.35	812.16	837.25	887.45	1011.37	995.29	712.55
Non-farm cash income	540.00	486.67	544.71	535.69	459.61	511.76	542.75	581.57	618.04	521.57
Total income	1062.35	1092.16	1201.18	1238.43	1271.76	1349.02	1430.59	1592.94	1613.33	1233.73
Cash farm expense	361.18	304.71	328.24	342.75	356.86	520.00	497.65	438.04	390.20	359.22
Farm household cash expenses	737.65	703.14	743.92	758.82	754.90	774.90	885.10	780.78	717.25	746.67
Total expenses	1098.82	1007.84	1072.16	1101.57	1111.37	1294.90	1382.75	1218.82	1107.45	1105.88
Net farm income	161.18	301.18	328.24	359.61	455.69	317.65	389.80	573.33	605.10	353.33
Net income	-36.47	84.31	129.02	136.08	160.39	54.12	47.84	373.73	505.88	127.84

Source: Wattanutchariya and Jitsanguan, (n.d.).

Additionally, farmers burning biomass to clear land areas for crop production can also negatively impact their own health, and that of many others, whilst damaging their livelihoods and bringing negative publicity to areas that will hamper their development. Chiang Mai is one such area that actually has people leaving it as a result of its poor air quality resultant from such practices. In 2020, it was named as having the worst air quality in the world (National, 2020).

As an example of what can be done to address biomass burning in that and other areas through adopting smarter farming practices, mention is made of research by Punyalue et al. (2015) which shows that “relay cropping” maize with legumes can both reduce biomass burning and increase crop yields. Those authors noted that maize grain yield was 24 to 53 percent higher for maize-legume relays than it was for maize monoculture. It has additionally been shown that in addition to reducing biomass burning, increasing profits for farmers, and helping improve health and wellbeing, legume intercropping with maize can also improve soil fertility and reduce soil erosion (Punyalue et al., 2018). Other smarter farming practices that address the causes of poor health and poverty are available too.

There is also the pronounced internal migration within Thailand due to many people moving from rural areas to urban areas because of such situations, leading to rural decline. At the moment there is a situation that many are seeking to

address particularly younger generations in access to agriculture-related which show how wide gap and unable to express their opinions openly to understanding the live of Agrarian and inequality in farmland sector (White, 2012).

2.1.3 The impact effect on agriculture

"Gross Domestic Product (GDP) is the total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period" (Chappelow, 2019). It provides an indication of both a country's economic health and the economic health of different industries with that country.

With the decline in percentage of gross domestic product generated by agriculture, World Bank national account data and The Global Economy has indicated value-added in the Agriculture, forestry, and fishing (% of GDP) in Thailand. The actual proportion of the value that agriculture adds to Thailand's GDP has been decreasing due to rising industrialisation within the country since the 1960s. As an example of the extent of that decline, a comparison of a recent value of 8.12% of GDP in 2018 is made with the 36.44% value achieved during the 1960s (TheGlobalEconomy.com, 2019; Data World Bank, 2019) as shown in Figure 2.1.

Despite the degree to which agriculture contributes to the economy, the majority of labour force in agriculture employment has been decreasing and it has been indicated that farming households are amongst the poorest in Thailand. As KResearch (2019) forecasts that overall farm price in Thailand has dropped across the board and effect to economic crops, following a 5.9 percent of over the year due to trade surplus and demand reduction from China.

Despite that decrease, agriculture is still responsible for around a quarter of all exports as determined by value, and agricultural activities are undertaken on around 30% or more of this country's land area (Singhapreecha, 2014). There is a need to increase its presence, and what it is capable of, within the global marketplace.

Such challenges are in part created by the predominant use of agrochemicals in farming, problems of soil erosion, flooding, droughts, and global warming. The cultivation of monocultures can also create additional risks to the farmers that grow them, as can market fluctuations in crop prices and product demand.

The shrinking of rural community as more individuals move to the cities is also an issue that is seldom addressed.

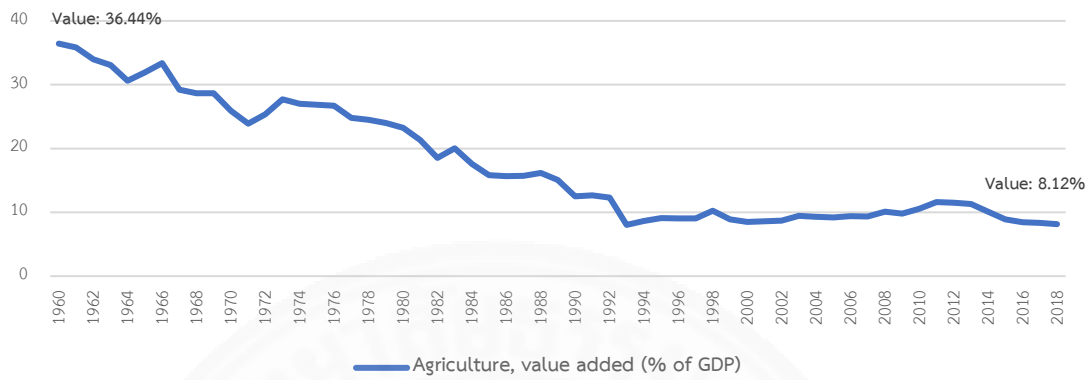


Figure 2.1 The contribution of agriculture to Thailand's GDP from 1960-2018
Source: TheGlobalEconomy.com (2019); Data World Bank, (2019).

Although spatial concentration can provide economy of scale, the release of Thailand's main crops into the market at the same time can create oversupply and lower prices. Moreover, the ageing of the population has become a global phenomenon which challenges all of the critical societal systems including a family, culture, medical and health, and a person's value (McKinney, 2018). The ageing community within the farming population, and the perceived barriers they have to face, present one of the obstacles to the adoption of new agricultural processes, including the adoption of new methods and modern technology (Rigg et al., 2019; Attavanich et al., 2019). The over-reliance on high-tech ways to provide knowledge may also create an additional barrier, one that could perhaps be addressed by providing information in ways that are more user friendly to key stakeholders.

2.1.3.1 Chemical farming and pollutant exposure, carbon emissions and drought

The impacts created by chemical farming, burning of biomass, and the adoption of monoculture approaches have contributed to a reduction of GDP in Thailand.

1) Biomass burning

Biomass burning, is a traditional agriculture practice whether undertaken deliberately to clear forests to create agricultural land or to remove crop residue. It can also be caused by accidental wildfires. The pollution it creates can significantly affect individuals' health, reduce local air and water quality, and also greatly contribute to soil pollution. It has been estimated that around 18 percent of CO_2 emissions created by human actions are as a result of biomass burning (Jacobson, 2014). However, selling the biomass residue instead of burning it can create additional sources of income, and may stop farmers burning stubble after crop harvesting. Smarter farming methods can reduce the occurrence of biomass burning and also increase the revenue farmers receive from what is grown on their lands (Punyalue et al., 2018).

2) Soil erosion and Soil degradation

Problems of soil erosion, which destroy the cycle of natural soil fertility, are not only a threat to food security for developing countries. They affect irrigation systems and water resource management too. This main factor caused when more unsaturated soil allow water to move freely, this can lead to riverbeds and gullies becoming eroded. It directly affects to economic crops and particularly production ability, which if continuously intense, can lead to reduction of agricultural land and eventual disappearance from an area. FAO models have estimated the levels of soil degradation that exist and shown that Thailand has very degraded soil in all of its regions. In facing such challenges can be created fluctuating crop values for farmers and can drive to abandon their farming land or even facing with high expense cost on continue crowing crops. Soil erosion is causing decreased crop yields and potential of food and the quality on production as well as affecting to livelihoods of farmers, their income and security for living (Gomiero, 2016).

It has been revealed by the FAO (2015) that the emissions are estimated to rise in million tonnes of CO_2 equivalent between 2012-2030 from agricultural soil (N_2O), and continue to rise from 2,114 million tonnes to 2,195 million tonnes; the emissions from enteric fermentation are predicted to increase from 2,080 million tonnes to 2,365 million tonnes; and the emissions from manure management are set to increase by 13.4%, which original adapted from FAO database and Down to earth website as shown in Figure 2.2.

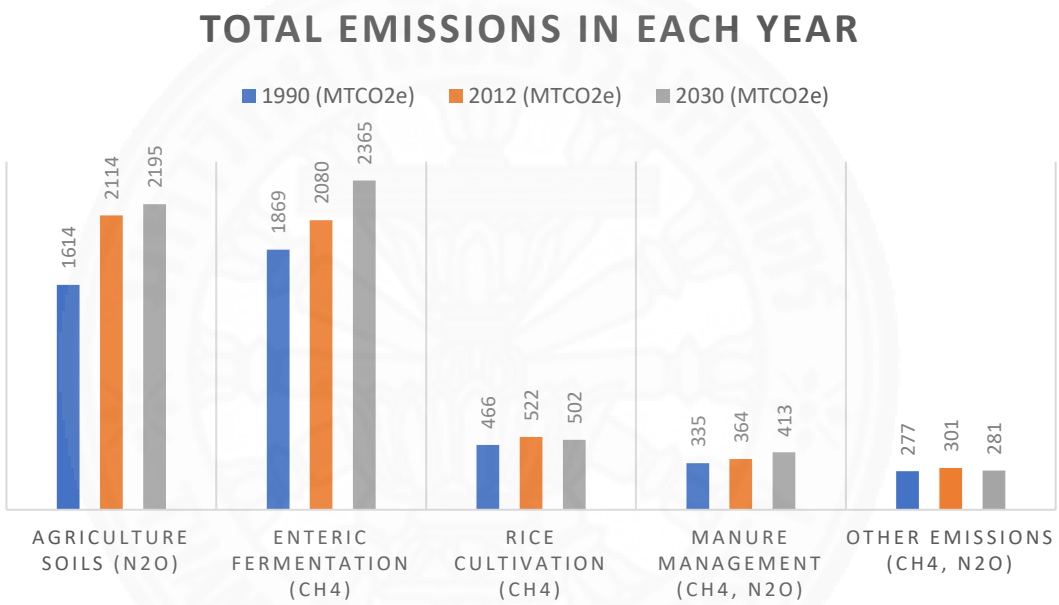


Figure 2.2 The different sources of agriculture emissions (in $MtCO_2e$)

Sources: Adapted from Food and Agriculture Organization of the United Nations; FAOSTAT database, FAO, 2015; Down to Earth, (n.d.); Big Facts (n.d.)).

3) Carbon dioxide emissions

Whereas the prosperity of the development will affect the supply of energy and amount of water used in agriculture. Especially, when the world is facing climate change that caused by global warming that became the consequence of agricultural crisis and likely to severely impact food production around the world. Many farming methods at present adversely affect biodiversity, reduce forest areas, and damage natural resources.

The changing in duration, temperature range and length of each season in Thailand effects work on farmland and in farmers' gardens. It means that growth of many important agricultural crops tends to change. The United Nations Food and Agriculture Organization (FAO) estimates that by 2030, climate change will have serious effects on agriculture in every part of the world unless drastic changes are made to address it as soon as possible (FAO, 2016, p. 59).

Based on the assessment of greenhouse gas emissions and mitigation potential by GLEAM 2.0, it has been calculated that the emission by species in the livestock sector contributor to global human-induced GHD emissions. The Production of cattle (beef) and dairy milk has contributing around 41% and 20% of emissions, while the production from pig meat and poultry meat and eggs has contributing around 9% and 8% of the emissions sector which original adapted from Gerber et al. (2013) as shown in Figure 2.3.

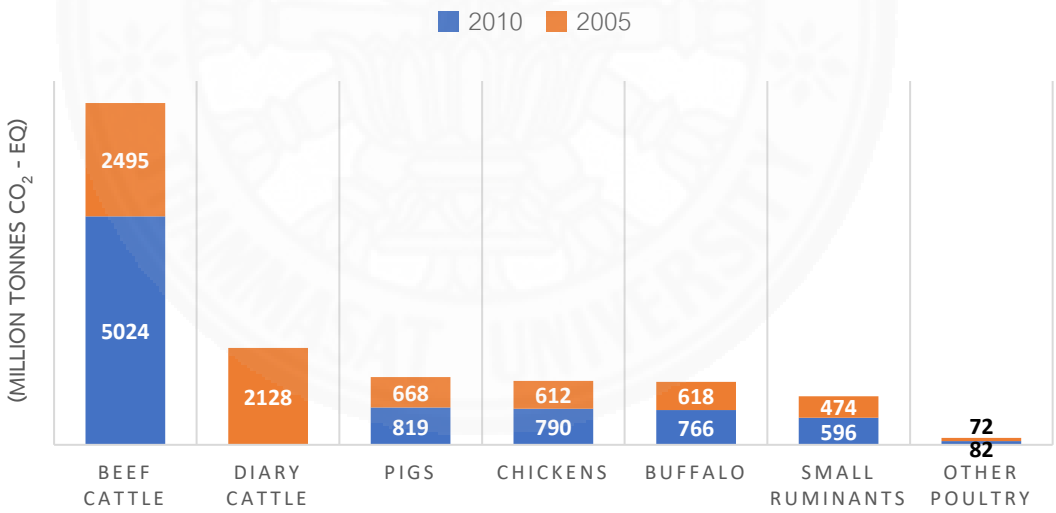


Figure 2.3 Global estimates of emissions by species

Sources: Adapted from FAO, (2013a), p.16; GLEAM 2.0; Big Facts (n.d.).

With the different sources of agriculture emissions, chemical import list, and the toxicity level of pesticides, these all can be brought to measure how each area should be trying to improve its performance.

4) Problems created by chemical farming and pollutant exposure

Since Thailand's agriculture has undergone a major adjustment and the world awakening of the Green Revolution simultaneously which mainly changed Thailand's agricultural model from product consumption in household to sale for farmers to buy other products needed. It trends apparently began with the use of various chemicals as a factor of production that can impact their health and bank balances (Facts and Details, 2014), coupled with technology and agricultural machinery. Despite its strength in bring the scientific and technological advancements to increase the productivity of agricultural products. It causing impact of neglect which consist of society and environment, especially the impact on the ecology and no consensus has yet been apparent on these intensive methods can make a successful development strategy (Smuthkochorn, 2016).

Even though conventional farming requires the increased use of chemical fertilizer to help crops grow faster, the use of intensive fertilizer can detrimentally affect the quality of soil. This process has a residual effect and can cause the soil to become acidic as a result of fertilisers being transformed into nitrate by microbes. In addition, the use of chemical fertilizers that cause nitrate contamination in water sources can affect human health and generate soil pollution as well (Savci, 2012).

A chemical inhibitor of plant growth, paraquat has a damaging effect on plant tissue has acute toxicity and affects hormonal balance. Its absorption may lead to myocardial, pulmonary, hepatic injury and renal body injury in humans. The World Health Organization (WHO) has designated Chlorpyrifos as a moderately hazardous compound. as well as carbaryl which moderately to very toxic and effect through inhalation, ingestion or skin contact. Fungicides in plants which can lead to in human, especially can lead to impact on pregnancy and impaired cognitive function and motor development in children.

Table 2.2 Top ten imported herbicides, insecticides, and fungicides by active ingredient (a.i.) into Thailand in 2013

Rank	Herbicides		Insecticides		Fungicides	
	Name	a.i. (Kg)	Name	a.i. (Kg)	Name	a.i. (Kg)
1	glyphosate isopropylammonium	27,994,397	chlorpyrifos	1,193,302	mancozeb	1,513,307
2	paraquat dichloride	13,823,092	cartap hydrochloride	663,197	carbendazim	644,246
3	2,4-D sodium salt	6,361,633	carbaryl	592,587	propineb	548,961
4	2,4-D dimethyl ammonium	6,121,701	cypermethrin	504,931	captan	472,197
5	ametryn	4,621,614	carbosulfan	432,191	copper hydroxide	459,518
6	atrazine	4,284,683	isoprocarb	382,785	propiconazole	354,286
7	butachlor	2,368,861	dichlorvos	320,994	difenoconazole	347,803
8	diuron	1,776,238	chlorpyrifos+ cypermethrin	263,009	phosphonic acid	245,669
9	acetochlor	1,164,241	fenobucarb	215,289	fosetyl-aluminium	233,929
10	propanil	987,142	profenofos	189,467	metalaxyl	152,848

Source: Tawatsin et al, (2015).

Comparison of the toxicity level of 12 surveillance pesticides by using the World Health Organization (WHO) standard values and the LD_{50} or human toxicity level are shown. The calculations are based on experiments with mice as shown in Table 2.3.

Table 2.3 Comparison of the toxicity level of 12 surveillance pesticides

Impact on agriculture: Carbon footprint	**Full (IA)**	**Neutral (IB)**	**Less (II, III)**
Type of chemical use that effect to people (LD_{50})	Aldicarb (0.93)	Blassticidin-s (16)	Endosulfan (80)
	EPN (14)	Carbofuran (8)	
	Ethoprofos (33)	Dicrotophos (22)	
	Parathion Methyl (14)	Methidathion (25)	
		Methomyl (17)	
		Oxamyl (6)	

Source: Adapted from Department of Disease Control (2016).

The predicted severity of climate change is due in part many farmers still undertaking chemical agriculture. Such farming detrimentally affects farmers' income and quality of life, and compromises agricultural growth relative to other economic sectors, and results in increased competition in the world market. When undertaking this type of farming, many farmers have dangerously high levels of household debt and high probability of having difficulty paying their debts due to fluctuating sale prices.

Even as the Ministry of Agriculture and Cooperatives in Thailand plans to develop and drive important policies and programs to help revitalise the agricultural sector, such as Smart Farmer development and promoting the use of innovation in parallel with agriculture, many studies show the risks farmers experience in relation to carcinogen exposure, including pesticides, engine exhausts, fuels, being over-exposed to solar radiation, wood dusts, and burning waste (Darcey et al., 2018). With this in mind, caution is also required with many of the presently proposed smart approaches for farmers that require the use of wireless technologies as the International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as being a Group 2B carcinogen, with some experts calling for it to be upgraded to a Group 1 carcinogen (WHO, IARC, 2011; Hardell and Carlberg, 2019).

A smarter choice of the methods and the technologies (such as bio-friendly smart technologies that can be used in farming) is required to drive the development of more sustainable and ethical development of farming practices that work more in harmony with nature.

5) Drought

Periods of drought within Thailand are presently being exacerbated by climate change and conventional farming methods that have high water usage. It has been observed that the severe drought is adding further stress to Thailand's besieged economy, particularly for those in agricultural production (Bangkok Post and Bloomberg, 2020).

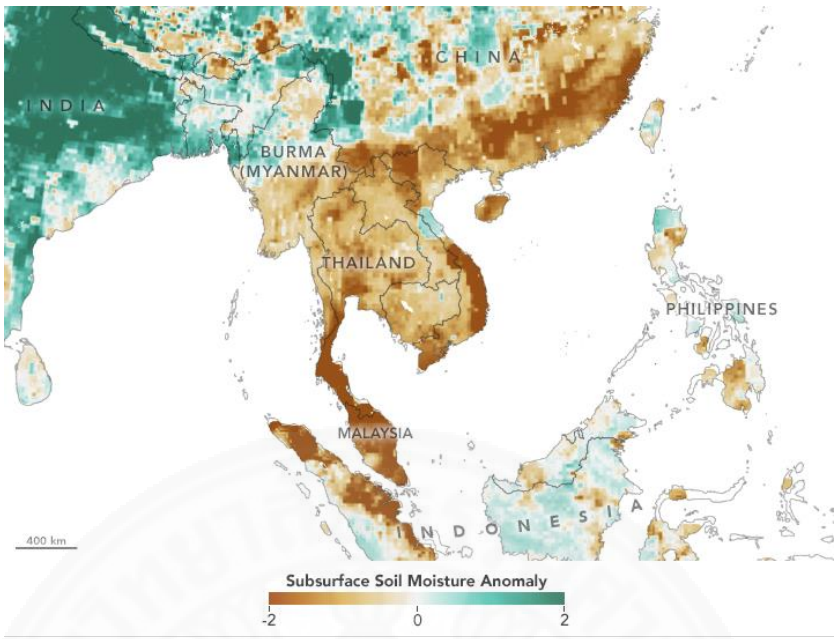


Figure 2.4 Thailand is presently experiencing its worst drought in four decades
Source: NASA, (2020).

It has been predicted that as a result of the widespread drought, sugar production may drop by around 30% (Bangkok Post and Bloomberg, 2020). It is suggested that smarter organic farming may already be able to help address this issue using low-tech measures. Other parts of the agricultural industry have also been severely affected and hardships brought to the lives of those who work in it.

Furthermore, it was reported by the Department of Disaster Prevention and Mitigation that between 17 October 2019 and 6 February 2020, drought disasters were declared in 116 districts within 20 provinces across Thailand (National, 2020). The Thai Government is legally required to provide assistance to help address them. It is proposed that the SATI (Smarter Agriculture Thai Initiative) may prove to be a very cost-effective proactive initiative that could be adopted to help address such issues in advance.

2.1.3.2 Smarter agriculture initiatives to help address CO_2, flood and drought issues

There are a number of smarter agriculture initiatives that could be adopted by Thai farmers to help address climate change and agricultural mismanagement issues. These include: planting cover crops; relay cropping; using drip irrigation; using conservation tillage instead of ploughing fields; and adopting organic farming techniques to improve crop yields and enhance both water uptake and drought resistance.

1) Planting cover crops

These can be planted in addition to the main crop and help cover soil that would otherwise be left exposed and be more prone to erosion and water evaporation. It has been shown that planting such crops also helps reduce soil compaction, so that it can absorb more water in times of intense rain, and enables crops to survive drought better (CUESA, 2014).

2) Drip irrigation

In comparison to many conventional irrigation systems, the use of drip irrigation can result in up to 80% water savings (UMass Amherst, 2013).

3) Relay cropping

Undertaking this can directly help reduce CO_2 emissions as a result reduced biomass burning being undertaken, and help reduce flood and drought issues through improving soil fertility and reducing soil erosion. It can also greatly increase farmers' earnings (Punyalue et al., 2018).

4) Conservation tillage

Undertaking conservation tillage instead of conventional ploughing compacts the soil less. It can also help improve water uptake and reduce water evaporation and soil erosion (CUESA, 2014).

5) Organic farming

Growing organic crops and having organic matter in soils can help greatly increase soil water storage capacity, help recharge groundwater more efficiently (15-20% improvement on that obtained with conventional crop areas), enhance drought resistance, improve crop yields during drought (by 15-20%), and aid

carbon capture (Nick, 2018; Cornucopia Institute, 2013; Gould, M. C. 2015). Furthermore, it has been indicated that organic agriculture soils can be better at long-term carbon storage than traditional agricultural soils (Ghabbour et al., 2017).

Additionally, as a further example as related to reducing CO_2 exposure, Thai Smart Farmer (n.d.) documents how farmers can reduce their farming costs without having to burn straw. Other measures are also discussed on their platform.

2.1.3.3 The growing market for organic produce

With regard to the consumer perspective on organic produce it has been show that there is a growing market for organic produce in Thailand, and abroad. It has been shown that consumer behaviour, in Thailand and abroad, is increasingly recognising organic food as a being a better choice for those wishing to live healthier lives. This change is not only viewed as new trend but also considered a new way of life. People who are interested in organic food and eating more healthily now actively seek food that is created without using pesticides or chemicals, and are prepared to pay a premium for it. The turning point with regards to organic farming began with consumers talking directly to farmers, and demonstrating a willingness to pay higher prices for organic food for the sake of their health. The continued growth in the organic market is what has become one of the major factors to drive farmers to seek more sustainable farming methods (Auamnuaychai, 2019).

Increased provision of organic produce is essential to tap into this growing market, which means that more farmers have to be trained to undertake farming production without using synthetic chemicals, artificial fertilizers, pesticides, herbicides or fungicides. This means, literally, more Thai farmers going back to their roots with a modern perspective, as from the earliest time, in the ancestral era, organic farming has been used for producing agricultural crops. It is only in recent times that this kind of farming had become more of a rarity.

Kasikorn Research Center of Thailand estimated that the growth trend for the market value of organic products was around 2,700 – 2,900 million baht in 2019, covering non-food products and organic agriculture products (K SME Analysis, 2018). The domestic market represented 30 percent of that figure and the

foreign market the remaining 70 percent of the total market value. 80 percent of the overall total given was for organic food and beverages, while the remaining 20 percent is for non-food products such as textiles.

SCB Economic Intelligence Center (2017) observed that consumers are willing to pay a premium price for 15% to 50% more for organic food, which contrasts with the lower prices of most of Thailand's standard agricultural commodities (corn, tapioca and soybeans). Major consumer willingness to purchase organic food exists in countries such as Brazil, India, and China where there increasing for better food quality (Li et al., 2019). Over the period of 2010 through to 2014 in Thailand, sales of organic food produce up to 7% annual rate while above the 5% growth rate of regular conventional food. Conversely, the main organic food is rice, coffee beans, fresh vegetables and fruits, etc.

According to research by Ecovia Intelligence (2019), the global market for organic food and drink has shown substantial growth in recent times and exceeded $100 billion for the first time in 2018, with North America and Europe comprising the majority of the worldwide sales and each area most using organic ingredients. The more consumer awareness of organic products has increased, the more it has become a major driver of global growth and sustainability.

With record growth in organic farmland, Australia is the world leader in organic agricultural land with 35.6 million hectares, followed by Europe which has the second largest area of organic agricultural land, and then Latin America (Research Institute of Organic Agriculture FiBL, 2019). Thailand's Ministry of Agriculture and Cooperatives has set the goals of: making Thailand become the organics leader of Southeast Asia by 2022; increasing its organic farmland: and boosting income from organic products grown by 20% within 5 years (Songwanich, 2018). It has been predicted that the market value for Thai organic products will increase at around 6.5 percent (CAGR) from 2020-2024 and will then rise further to 8.7 percent for the period 2025-2029 (Kasikorn Research Center, 2019).

Since the publishing of the above, it has been reported that due to the COVID-19 pandemic there has been a huge increase in demand for organic products worldwide. This is in large part been due to people wishing to purchase

healthier foods to help enhance their immune systems. As a result of this trend, Ecovia Intelligence (2020) predicts that worldwide, organic products sales could exceed $150 billion by 2025.

2.1.3.4 Effect on farmers life

1) Thai farmers often need to look for second careers

The problems of poverty and income inequality cause many farmers to find second careers because their main occupational livelihood does not cover their household expenses well enough, and there is insufficient security of income. In addition, preconceptions of older generations can lead them to experiencing age discrimination which can become a serious issue and further widen such gaps.

Whilst Thailand continues to have great success in exporting its agricultural products worldwide, the problems of poverty and income inequality within the agricultural industry cause many of its farmers to find second careers because their main occupational livelihood does not provide their households with sufficient security of income (Chantapong & Thepkam, 2018). In addition, productivity and net profit are often very low and many farmers must rely on the government because they have lack of sufficient knowledge to access the technology and resources, lack of ability in terms of bargaining power in a market and lack of marketing insights for production planning. The mentioned issue exhibit farmers still lack of sustainable development, especially the strengthening of self-reliance in the long-term.

Therefore, the government have to set policies to farmers to faces any problem challenges. Its significantly increases the net household income and the factors of production and cost of living continuing move up.

Over the last several years, the rise of ageing population has driven become a phenomenon that occurs in which vary according to whether the environment of each country or the changing of social structure, attitudes and values (Gajanandana, 2018). Especially agriculture which is a large sector in most developing countries, the changing in structure by moving closer towards an ageing society has affected both economic growth and decreased labour quality and numbers. Ageing in

farmer population are the obstacles to making decisions and learning in process of agricultural, which replaced by the use of machinery and modern technology (Rigg et al., 2019) as well as the deterioration of the financial stability and debt among Thai agricultural households and against to achieve sustainable development.

The transition into an aging society has become a very serious issue in agriculture. A work condition survey in Thailand found that the labour force in the agricultural sector has increased by 13.36 million people, which accounts for up to 34 percent of all its registered workforce, while the proportion of income from agriculture to GDP is only 10 percent (Thai National Statistical Office data, 2018).

Also, it has been shown that the proportion of agricultural workers older than 60 years of age had increased from 13 percent in 2003 to 19 percent in 2013, and that the proportion of young workers (15-40 years) had dropped significantly from 48 percent to 32 percent over that period. This reflects a serious labour shortage of young workers in the Thai agricultural sector.

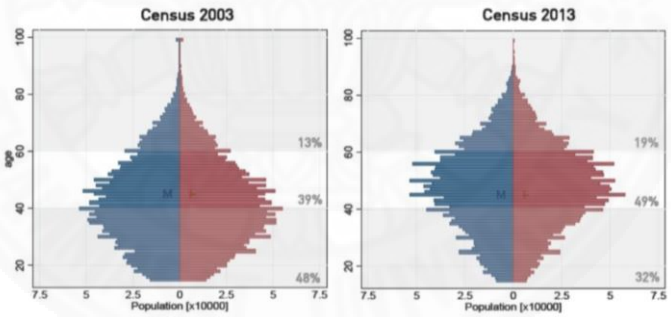


Figure 2.5 Labour in Agriculture by Age and Gender
Source: Attavanich et. al., (2019).

In addition to the reduced proportion of younger agricultural workers, the average size of farms is also declining and was typically around 20 rai (7.9074 acres or 3.19702 hectares) back in 2013, while Rerkasem, B., (2016) has estimated that households require 62.5 rai (10 hectares) to produce sufficient output, and that such farm sizes are effectively too small to get an income that meets farmers' requirements (Phongsiri et al., 2019). A comparison of the average age of farmers in selected Asian countries is provided by Rigg et al., (2019), as shown in Table 2.4.

Table 2.4 Farmers' average ages in selected countries within Asia

Country	Age (years)	Date
Vietnam	37	2006
Cambodia	39	2015
China	50	2016
Thailand	51	2012
Indonesia	52	2010
Philippines	57	2013
Malaysia	60	2013
Taiwan	62	2010
Republic of Korea	65	2013
Japan	70	2013

Source: Adapted from the Ministry of Agriculture and Cooperatives (MOAC) which reveals that the average age of Thai farmers is 51 years of age (Rigg et al., 2019).

2) Existing trends

Such changes in the proportion of younger agricultural workers in the workforce and the average size of farms have direct impacts on agriculture. Additionally, the higher levels of competition, alongside demand patterns for food types, climate change issues, and the technological revolution, have also caused great disruption. Added to this, often older farmers are risk averse, and reluctant to adopt new technologies and approaches. Many people seeking to create change forget to work with that fact and see how it can be better addressed.

The key behavioural biases observed in field studies of 250 farmers from Pathum Thani and Kalasin provinces revealed the following: 85% of them demonstrated 'present bias', which is often associated with having low levels of insurance or savings. This bias was shown to the most pronounced for those who were least wealthy. 35% of the farmers were shown to be extremely risk averse, with this bias in particular being shown to be greatest in those who are low-tech farmers. 80% stated that they had some level of loss aversion (Attavanich et al., 2019; Chantarat et al., 2019). The indications from that research are that when farmers are both risk averse and loss averse, they are less likely "to invest and adopt new farming practices and/or technology" (Attavanich et al., 2019).

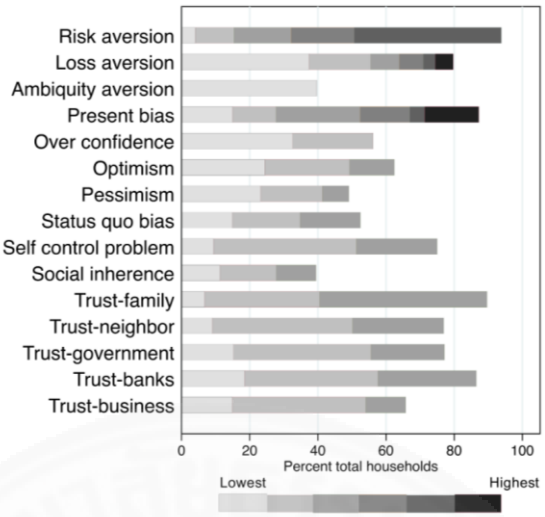


Figure 2.6 Thai farmers' behavioural biases

Source: Attavanich et al., (2019) and Chantarat et al., (2019).

3) Debt, economic conditions, labour issues of Thai farmers and net farm income

Income and debt within Thai agriculture are considered as important indicators of the development of Thai agricultural households, in which decisions and economic outcomes are mainly dependent on the householder. Almost 40% of Thai agricultural household's average per capita income is below 32,000 baht, which was Thailand's poverty threshold in 2016. And 30% of all agricultural households have debt more than once per capita income per year, which may occur due to factors such as the level of education within the household, the size of cultivated land, land lease, and use of irrigation systems.

According to the Statistics by The Office of Agricultural Economics the production cost of key crops is the largest contribution in total cost, and in 2013, growing in-season crops resulted in negative net farm income which was possibly a key factor leading to the rising of household debt (Attavanich et al., 2019).

2.1.3.5 The concentration of economic crops

After the green revolution, Thai agriculture made remarkable progress in terms of its dynamic and rapid economic development, which resulted in

Thailand becoming a major exporter of agriculture products. However, the World Bank (1990) pushed the countries that grow rice in Asia and mainly export their agricultural products to start encouraging farmers to do other crops as well in order to help solve the problem of oversupply of goods by diversification in order to reduce the fluctuation of income that results from variations in agricultural prices.

As a national overview, it can be seen that more than half of Thai agricultural land grows rice and glutinous rice, while a third grows major economic crops (including cassava, corn and sugarcane) and perennial plants (rubber and palm oil). The dark green areas shown in Figure 2.7 represent rice cultivation areas which are chiefly concentrated in the provinces in the Northeast and around Chao Phraya River. The areas shown in pink in that map indicate that Thailand's rubber plantations that are mainly concentrated in the southern provinces. Although the spatial concentration of particular crops can often create benefits related from Economy of Scale, the main produce from individual crop types in Thailand often still continues to be released onto the market at the same time, creating the joint problems of oversupply and lower prices. As examples: Rice production comes out from the northeast region during the month of November; Cassava in January – March; Maize in September – December; and Sugarcane in December - March.

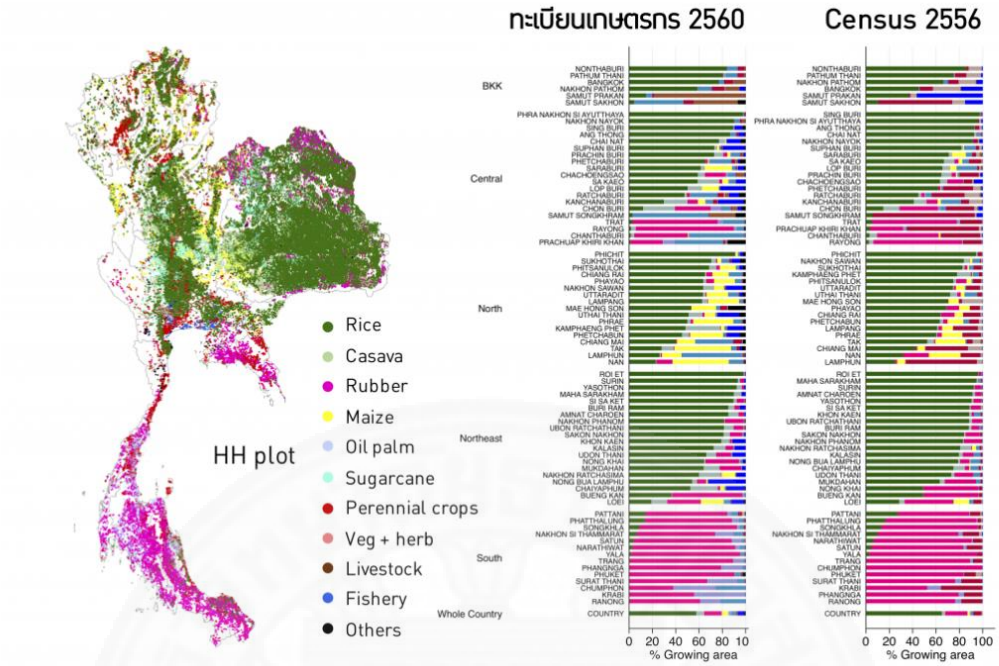


Figure 2.7 Indication of diversity of agricultural activities, and the concentration of economic crops and households that practice agriculture in the area
Source: Attavanich et al., (2019).

2.1.3.6 The cultivation of single crops versus the cultivation of multiple crops

Two in three agricultural households currently grow monoculture crops. 27 percent live in Northeast and 9 percent live in South of Thailand. Only 32 percent have on-farm diversification, consisting of: (1) 27.0% sticky rice and glutinous rice (2) 6.1% glutinous rice and cassava (3) 4.5% glutinous rice and rubber (4) Glutinous rice and sugarcane 3.4% (5) Glutinous rice and rubber 3.4% (6) 3.1% Glutinous rice and cassava and (7) 2.8% Glutinous rice and corn (Attavanich et al., 2019).

In addition, when considering the proportion of elderly workers in 2013, it was found that most of the elderly workers have a high proportion of fruit growing, fishery and livestock activities. It was additionally found that young labourers are more likely to do the activities of growing economic crops such as palm oil, rubber, cassava and sugarcane (Attavanich et al., 2019).

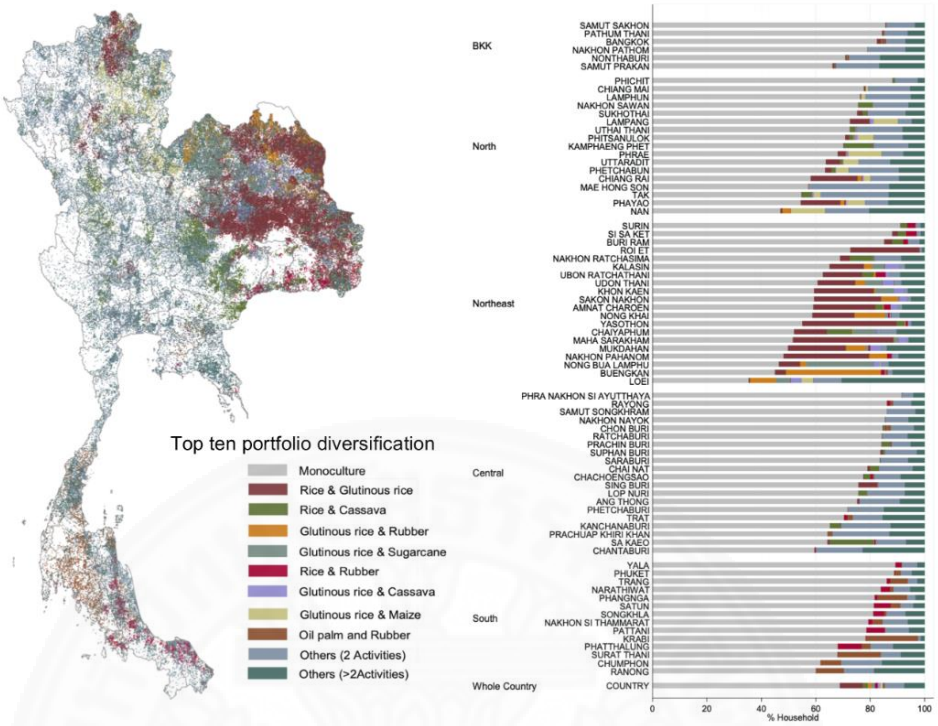


Figure 2.8 Type of agricultural practice show 2 in 3 households produce monocultures (gray spots)

Source: Attavanich et al., (2019).

Produce diversification is one of the methods that can be undertaken to enhance farmers' ability to adapt. However, in some contexts, can lead to a reduction in the returns they receive as a result of a decrease in specialisation and economy of scale. According to Babatunde and Qaim (2009), diversification can be described as a risk management strategy to give an appropriate overall income to agricultural households in developing countries such as Thailand. The agricultural production sector is often highly labour intensive, and in many cases human labour cannot be easily, or inexpensively, replaced by technology. The age of farmers also has a tendency to influence decisions and learning in the agricultural and productive processes. It points out the reduction of response, learning and technology use.

Even though there is evidence that the aging population can slow economic productivity, it should not be denied that older generation farmers can still be outstanding resource in terms the potential they possess to be able to share

their knowledge to help develop a new generation of Thai Farmers to be more efficient and learn from their hard-earned experiences. Merging the experience, wisdom and assets from olderly workers with the ability to learn, decision and adaptation the technology of younger may good for productivity within appropriately allocated.

2.1.3.7 How COVID-19 impacts on agriculture, farmers and food systems

The World Food Programme (WFP) estimates that the coronavirus pandemic (COVID-19) could threatened global food insecurity and nutrition by end of 2020 which not just killing but also ravaging food production which changing in the way we produce, process, delivery to customer and cooking, and affecting to the global supply chain especially in terms of global consumption habits as well as food system digitalization. Therefore, it reveals the structural problems and emphasized an inequality in the Thai economy (Regional Innovation Centre UNDP Asia-Pacific, 2020).

Almost all nations are struggling to slow down COVID-19 transmission, since the initial infection of even limited numbers of people can result in widespread outbreaks and high loss of life. Thailand has been one of the countries that has tackled the pandemic crisis strongly, and governments have the power to shut down entire cities to seek to contain the outbreak by limiting non-essential travel, keeping practicing physical distancing at events or crowded places, self-quarantining and isolation in a safe area or at home. Some smaller economic units, such as individual businesses and organisations within large cities are all affected by the temporary closure or disease prevention measures. Such situations reinforce the problem of economic inequality, especially for some people who are struggling to make a living and are more vulnerable to infection than others, which resulted in acceleration of the situation.

As economic units are shut down, it has led to panic buying with people flocking to supermarkets and stockpiling food which has increased demand for agricultural products and raised food prices. This area has become a potential sector that to support the impacts of unemployment. In the meanwhile, a

large number of migrant workers in city and rural areas, many of whom are from abroad, have moved back to their own countries.

At present there has been broad public support on the guidance to stay at home and social distancing measures which have greatly reduced the overall amount of infection and helped protect public health. It has however resulted in 43% of agricultural households losing their income, and 30% also losing income from doing other businesses (Chantarat, 2020a). The next factor, is that agricultural households still often rely on money earned from working in the cities and abroad to pay back their debts and help cover their living expenses when there is little or no income. In addition, parents involved in farming may have no cashflow to pay for their children's education, and face other restrictions through school closures and dismissals.

During the COVID-19 pandemic, people have been asked to self-quarantine whether they are infected or not. For others, social networking has demonstrated the potential of interconnectivity in everybody's life both in the cities and farmer institutions, in particular with regard to cooperation in public health measures for communities. For some people, the practice of growing edible plants and raising new crops has arisen, and with most households being quarantined, home gardeners have heightened public awareness of world food security and created a chance to grow more food (Manning, 2020).

There is empirical evidence from interviews with farming households in Thailand, that were randomly chosen from Thai farmer registration, about the response of farmers since April 2020 which found that unprecedented measures have been taken in response to the outbreak has disrupted produce transportation, logistics, and changed market demand. The results obtained show that 76% of households were depend on non-agricultural income and 62% relied on income from non-agricultural occupations. The Bank for Agriculture and Agricultural Cooperatives (BAAC) found that 4.5 million households are more than 200,000 baht in debt and 20% of those surveyed are more than 400,000 baht in debt. This may affect the economic development of such households in the long run (Chantarat et al., 2020b).

From a different perspective, this crisis presents opportunities to have quality young labour and radical rethinking becoming important forces in the development of the local economy and the Thai agriculture sector. The COVID-19 pandemic, and resultant economic downturn, are forcing farmers and farming communities to become more resilient in order to survive. The chance to learn and use the best of high-tech and low-tech approaches, in order to build strong local economies within communities, can also increase productivity, add extra value and increase market access to agricultural products.

The research also pointed to the needed for adaptation of Thai agricultural households in both production and market awareness to the changes in consumer behaviour resulting from the pandemic crisis, which may lead to a new normal in the future. In the meantime, CPTPP (The Comprehensive and Progressive Agreement for Trans-Pacific Partnership), a free trade agreement that covers trade, service, investment of having the common standards and regulations between member countries and relevant intellectual property rights, labour standards, and environmental laws, as well as standardised procedures for dispute settlement between governments and foreign investors. This controversy might make food more expensive for both consumers and cultivators, and could be legally empower large companies to take over rights related to Thai seeds.

The Department for International Trade considers that Thailand would gain advantages through signing into the CPTPP which would help the growth of GDP by providing further opportunity of Thai exports to member countries, attract additional international investment, increase export and employment rates, and provide a measure of competitiveness.

On the other hand, some concerned members of the public point out that participation in this agreement still has potential to create sensitive issues related to service and business movement in Thailand, and may result in lost benefits to foreign investors due to the negative-list negotiations and also the effects on others on issues such as food security and access to certain medicine.

There is major concern that the agriculture industry will face more competition from member countries and that this might cause agricultural costs

to significantly increase and earnings significantly drop if there is trade liberalisation. There is also the issue of foreigners and corporations selecting Thai native plants for research in order to develop new plant varieties and register patents on what are in effect Thailand's natural resources and nature's intellectual property. Such actions would have direct negative effects on Thai farmers, particularly if they are prohibited from saving seeds for planting, especially the seeds of species that their ancestors have developed over many generations and also impact plant breeding by agencies, and the livelihoods of livestock farmers and forage crops farmers (Chalermpalanupap, 2020). Farmers need to be able to retain their independence and reliance on natural resources. "Thai" actually means "free" or "freedom-loving". It is important that such an important part of our country's identity and core values be recognised.

The recent situation has underscored the need for an opportunity to improve the situation for those with little access to modern technology and hard-earned wisdom and highlight the need to reduce inequality for all. It is proposed that the SATI (Smarter Agriculture Thai Initiative): A Smarter Organic Farming Model for Thai Farmers Guideline could help assess, guide to prepare, and readiness within among disadvantaged and vulnerable communities for enhance the well-being. It might create the connection from communities, welfare organisations, development agencies that ready to mitigate the impact of the ongoing situation and the economy swiftly recover once.

Additionally, it is suggested that a financially viable transition over to smarter agriculture by farmers needs to be more readily achievable and by a wider range of participants. Living in debt and poverty should no longer be an option and needs to be urgently addressed. This is especially true for older members of the farming community. Agriculture and Cooperatives Minister General Chatchai Sarikulya has already discussed some of the challenges being faced and what could be achievable: "If our smart farming policy achieves its goal, we should be able to help farmers out of the middle-income trap within the next two decades" (Saengpassa, 2017). It is proposed that with the SATI model such a transition could actually be achieved far faster.

2.2 Smarter organic farming

There is a growing market for organic produce and a need to produce it more efficiently to optimise the benefits it can create.

Organic farming was the original kind of farming started by humankind and has been undertaken for thousands of years. Forest gardening, which dates from prehistoric times, is considered to be the first instance of it being undertaken (McConnell, 2003). It represents a sustainable method of agricultural production free from harmful man-made additives.

Undertaken correctly, the more widespread adoption of organic farming methods can increase farm produce quality, help maintain the biodiversity of nature's ecosystems, and enhance soil quality and productivity (Chinvarasopak, 2015). Accordingly, the conversion of farms to organic practices can help farmers become more sustainable and also help individuals obtain foods that are free from artificial pesticides and fertilizers (Auamnuaychai, 2019).

Organic agriculture provides environmentally friendly farming initiatives that can increase soil quality for the next round of crops and lead to benefits to consumers who are health conscious and seeking healthier products that are environmentally friendly. As noted by Auamnuaychai (2019), with regard to farmers, better awareness of: the barriers and challenges they face to adopting organic farming methods; their motivation factors; and the supporting factors that can lead to successful organic adoption, is required before Thai farmers adopt to organic farming in greater numbers. As observed by Auamnuaychai (2019), many farmers only undertake organic farming once they become aware of the actual cost benefits of doing so. A summary of the findings of in-depth interviews conducted by that author with farmers in Muak Lek in Saraburi Province, Thailand, on those issues is briefly discussed in Tables below:

2.2.1 The barriers and challenges to adopting organic farming methods

There are a number of factors seen as potential barriers and challenges by those wishing to adopt organic farming methods.

Table 2.5 The barriers and challenges to adopting organic farming methods

Internal factors related to organic approach	Requires a long period of conversion and is often perceived as being suitable for the sufficiency way of life rather than a commercial approach.
	Hand weeding approach cannot control weeds and disease on a larger scale. (The interviewees appeared to be unaware of organic alternatives, such as diluted raw wood vinegar (Princess Sirindhorn's Projects (n.d.)) that can be used to help control weeds and disease).
	Most people do not know how to undertake animal husbandry and disease control without use of chemicals, and think they would have to find the solutions they may need through online sources.
	Communication access is often not that effective at present and policies that support, facilities and activities have often not yet reached locals.
	Organic local markets for small scale farmers are sometimes not as attractive as the productivity of conventional farms. They have, however, increased in popularity since the interviews were undertaken.
Personal factors	Lack of knowledge and labour shortages related to dealing with weeds and natural disease, unable to control expenses. If they have no ability to obtain relevant information that would help them, farmers may not be interested in practicing organic farming.
	Effort, patience, and work tasks.
	Farmers not ready to take what they perceive are risks related to their decision making towards conversion from chemical farming.
	Indebtedness of Thai farmers tends to be a barrier to adopting organic methods.
External factors	Organic certificate: Attending training courses, such as those given by the Dairy Farming Promotion Organization of Thailand (DPO), could provide basic information on how to learn the basic concepts of organic agriculture.
	Weather conditions, soil and water quality need to be considered.
	Organic farming may often require high investment, particularly when converting from conventional farming, and initial investment returns might not be enough to encourage farmers to adopt such methods since it gives lower yield, and it may be thought of as uncontrolled and inconstant in comparison to chemical methods.
	Appearance: Even with the benefits of organic produce increasing in consumer awareness, their perceptions and decisions are still often based on food appearance, with conventional produce often being the superior choice in terms of aesthetics, with chemically-treated fruit often looking more appetising.

2.2.2 The motivational factors to adoption the organic farming

It has additionally been shown that there are motivational factors that can encourage individuals to wish to undertake organic farming.

Table 2.6 The motivational factors encouraging the adoption of organic farming

Attitudes toward organic farming	Chemical effects can cause long-term health impacts to farmers, their colleagues, families and communities. They can also cause adverse effects to consumer, and cause damage to the environment and the natural food supply chain. This situation has led to increased awareness on health and safety concerns. In the meanwhile, people are prepared to spend extra money to lead longer lives without fewer risks from health concerns.
	The negative attitude towards chemicals has become a supporting factor for farmers' properties to be continuously be chemical-free.
	Organics can provide good opportunities for those who lack capital investment because it has reduced production costs, and provides the opportunity of a better way of farming and business development.
	Live surrounding traditional way of life and communities doing local agriculture methods create a deep-rooted philosophy.
Knowledge	In one instance, being involved in filming an agricultural documentary was the main motive towards one individual's organic conversion.
	The organic system concept that was learned from an industrial agriculture documentary that was the cause of the inspiration to provide safety food.
	Learning abilities and techniques that can improve personal skills.
External factors	Available markets encourage potential adopters.
	Social responsibility / Awareness of ethical relationship between human beings and the natural environment with cautions to conventional farmers on environmental issues.

2.2.3 Supporting factors that led to successful organic adoption

There are a number of different factors that can be brought into play to help individuals achieve the successful adoption of organic farming methods. These are documented in Table 2.7.

Table 2.7 Supporting factors that led to successful organic adoption

Knowledge adoption	Collecting agricultural knowledge and techniques from other professional organic farmers, and receiving advisory techniques on to adopt and practice, as well as filming inspiring documentaries and "success stories" and "how to" lessons.
	Crop rotation to helps prevent plant disease and increase crop fertility.
	Comprehension of how biodiversity works and techniques of organic farming.
	Farmer characteristics: ambitious, steadfast, self-learning and open to self-development.
	Build all the resources within the farm, such as pond areas and livestock areas, using the best available methods matched to the specific sites and farmers abilities and willingness to learn to create efficient eco-system farms.
acilitating factors	Animal services: The ability to access good quality information and knowledge on how animals can provide important services, such as pest control, weed control, and natural fertilizers (from cattle, chickens, bats and goats, without the extra cost of artificial fertilizers), whilst supporting the organic approach.
	Critically focused on creating extra value from what would normally be perceived as waste in farm management in order to reduce the input cost, such as recycling fruit residues for animal food.
	The advancement of agricultural materials, technologies and innovation such as bio-fertilisers that provide better productivities while the traditional ways use experimental methods.
External support	The government can provide support in both financial and non-financial ways, such as funding and marketing assistance, can help encourage agritourism by helping promote and provide direct and indirect tools to support farming communities and help other ways of income to be generated within the community.
	Collaborative farm projects that gather small-scale farmers together can help boost potential organic farmers' productivity while reducing risks.

Table 2.7 Supporting factors that led to successful organic adoption (Continue)

The globalisation of information accessibility	Social capital provides an advantage that can help support the farm owner that make her gain more profits and the ability of social market, online resourcing as a distribution channel can help support consumer demand, consumer awareness and local production. The government supporting agricultural practices such as inclusive information accessibility, and offering marketing channels to establish the stable demand.
	Networking with surrounding farmers who have mutual interest in organic farming to become a group to help each other in production techniques, expertise, and marketing channels to maintain stability and address potential production shortages. The farmers' network can be strong and very helpful and enable people to collaborate together for bigger projects and expanded development. There will be relevant regular news information, brainstorming and others activities among the group.
	A place where lots of farmers, researchers, students, and government officers can meet, learn and share agricultural knowledge both physically and through electronic media.
	Understand plant characteristics and their seasonality, including how they can be chosen for specific temperature and climate scenarios for an area.
	The environmental support can be of benefit to natural eco-systems. Generation of optimised ecological environments as related to the specific geography of an area with regards to sustainably increasing its value and nutritional provision.
Essential skills for organic success farming	Planning and systematic management to keep the productivities flowing continuously throughout the year without gap.
	Integrated farming model / farm operation level
	Diligence, Patience and Passion / The Sufficiency Economy Philosophy of the late King as a principle model for living.
	Encouragement and empowerment to build farmers' confidence.

Organic farming initiatives can even be undertaken in high-tech ways that can increase their yield beyond what is achievable with the use of chemicals (Chen, 2018). Additionally, due to the increasing awareness amongst consumers with regards to health concerns and environmental matters related to food production, the consumption of organic products and supplements has become a favourable trend in Thailand and elsewhere. This is due in part to the increasing awareness amongst consumers with regards to health concerns and environmental matters, and the increasing belief in the benefits of eating food that does not contain chemical residues. A healthy growth of the organics market is shown in many parts of the world.

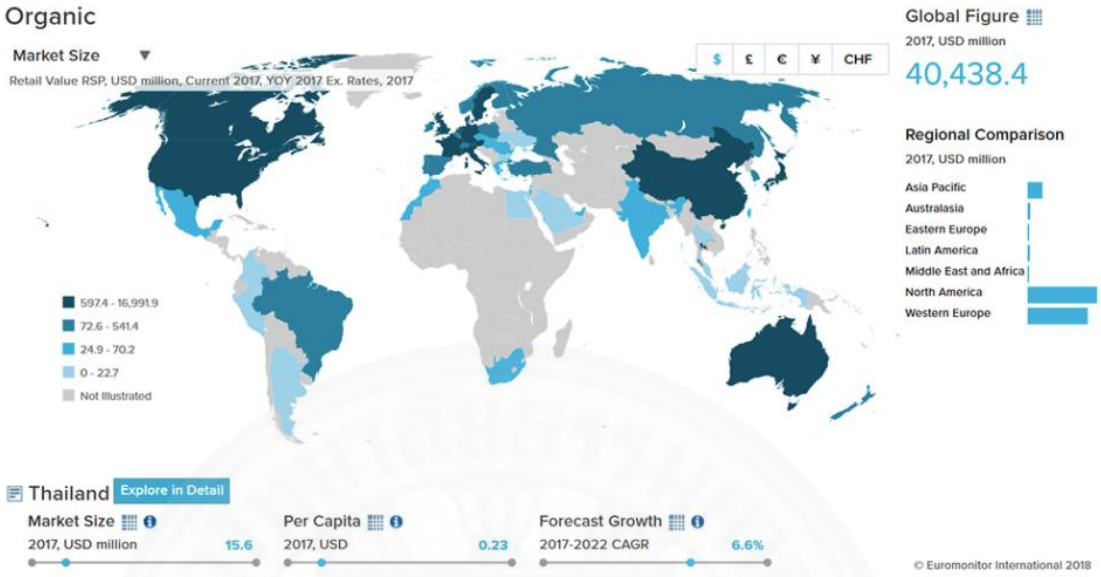


Figure 2.9 Global organic market size in 2017

Source: Global Organic Trade Guide, (2020).

The Kasikorn Research Center has previously estimated that the value of the Thai organic market at around 2,700 – 2,900 million baht and suggest that it will continue to rise up to 5,400 million baht as the government has predicted (K SME analysis, 2018). It is those within the middle-income and high-income pay brackets in particular that are prepared to pay a premium for organic produce. The increasing belief in the benefits of eating food that does not contain chemical residues provides the opportunity for farmers to diversify into new markets that provide premium product prices and better address the 3Ps. The issue of helping address climate change also presents new opportunities for growth and financial independence.

Research in the US by Northeastern University in collaboration with the Organic Center in Washington D.C., discovered that the increased soil fertility on organic farms has a potential for long-term carbon storage which is up to 26 percent greater than that found for conventional farms after analysing over 700 conventional farms in 48 states (Nargi, 2017).

2.3 The existing agriculture practices: agroforestry systems

Agroforestry can be described as a sustainable agriculture system in which tree-crops are produced through the integration of some, or all, of the following:

Providing fodder for livestock production, adequate availability to meet the demand of human nutritional foods and income of present generations, and produce a diverse as sustainable (World Agroforestry, 2019); Intentionally combining agricultural crops with herbaceous plants, forestry and pasture to create an integrated and sustainable land-use system which these practices are used deliberately on the same landscape and communities (Schoeneberger, 2009); Its ability to sequester carbon which can enhance agroforestry awareness among farmers (Karshie et al., 2017) and enable villagers and the global community to make better financially informed decisions regarding their agricultural activities (Gender Team in Forestry, 2018; Lundgren, 1982).

Overview of agroforestry system has identified as a dynamic, the creation based agricultural system that resemble as natural forest ecosystem. It enabling environment, and diversified production of other crops can increase long-term economic and social benefits at local and national scale (ICRAF, 1997; Elevitch and Wilkinson, 2000).

The International Centre for Research in Agroforestry (ICRAF), is an International Centre of Science and Development that has had its headquarters in Nairobi, Kenya, since 1992 (Mackenzie and Torquebiau, 2004). ICRAF was established in 1978 and Canada's IDRC supported the research it is developing. In addition, the activities of ICRAF has an ultimate purpose on providing evidence that agroforestry offers potential benefits through improved it systems and rural poverty on working with farmers, governments, training and institutions, in response to the global assist in the generation and development community, toward achieving the Sustainable Development Goals.

In mid-1995, the ICRAF decided to reach in advancing policies reforms at national level with Thai Government to develop the agroforests to encourage farmers to grow integrated agricultural crops. This participation will help more operation and

increase the coordination mechanism at the national and regional level and up-to-date with the changing conditions. Thailand is therefore one of six pilot research projects implementing ecological compensation mechanisms which in collaboration with Thai Royal Forest Department from Chiang Mai University in Thailand. The cooperation involves researchers, farmers, government and NGOs in Laos, Cambodia, Myanmar, China, and Vietnam (World Agroforestry, 2019).

2.3.1 Agroforestry systems used in Thailand

Agroforestry has long been practiced in Thai communities living in close proximity to natural forest areas, which rotational farming having been undertaken in many different parts of the country for centuries. Originally has been described as traditional agroforestry systems on help preserve the environment and it can be used to create a socially sustainable systematic combination of plant and crops, low-input cultivation techniques and that works in harmony with the cultural traditions of indigenous people without chemical or pesticide use and helps preserve both plant and animal biodiversity.

In the mid-1950s, the use of cultivated land in each area was led by market forces and the establishment of new agroforestry systems merged plants, crops and livestock. This helped reduce the encroachment problem in forest areas and recognised the importance to the grouping of plants at each related level, in terms of both supporting nutrient provision and providing the correct levels of sunlight and daylight exposures for different species of plants, including perennial plants.

Table 2.8 Types of agroforestry in Thailand

Practices	Farm-based agroforestry
Home gardens	Primarily for household consumption and traditional agroforestry system (Dagar and Tewari, 2017). Advantages - Multitiered systems which created within farmers' permanent family compound and communities in upland area. - The most notable was the Karen and the Lua ethnic group in the foothills, North of Thailand. - Typically feature between 3 to 5 layers of species providing shade for crops as multipurpose trees. Disadvantages - Home gardens tend to be small for land owned in the central region.
Live fences	- These are built as boundaries, shelterbelts and windbreaks on agricultural land to protect crops and prevent wind damage, and often feature the use of fast-growing trees and bamboo.
	Forest-based agroforestry
Small-scale commercial tree farming	- The planting of trees for commercial and investment purposes is sometimes undertaken on abandoned agricultural land often in upland areas.
Rotational agroforestry	Advantages - This involves cultivating different areas of sloping land including providing different fallow periods for each of those areas on a rotational basis. - It has been practiced and notable by the Karen and the Lua ethnic group in highland areas. - This system help preserves the biodiversity of indigenous plant and medicinal plants. Disadvantages - Inappropriate with high density of population and scarce land which requires sufficient land for rotation of cultivation.
Forest gardens	- These are located within walkable distance of rural villages and in the past were little monitored and loss from theft, fire, and livestock. - Typically trees and crops, including fruit crops, within these are cultivated at the same time. Livestock may also be kept free-range there.

Table 2.8 Types of agroforestry in Thailand (Continue)

	Forest-based agroforestry
Taungya system	- Considered as transformation from shifting cultivation (Dagar and Tewari, 2017). - The system allows locals either short or long-term rights to cultivate crops within forest plantations. In some situations, they are also sometimes permitted to graze livestock within those areas. - Government and private forest plantations being practiced which benefit for local people.

Source: FAO & IIRR, (1995)

Agroforestry can also spread risk through multiple types of crops being grown and can greatly aid CO_2 capture. There are three main ways that agroforestry can help address climate change through helping decrease atmospheric CO_2 levels. These are: carbon sequestration; carbon conservation; and carbon substitution (Murthy et al., 2013; Bass et al., 2000). It is proposed that, if developed on a sufficient scale, agroforestry systems have the potential to significantly, and cost-effectively, contribute to Thailand's carbon sequestration and help address climate action objectives through helping decrease atmospheric carbon dioxide concentrations, which in turn will lead to enhancing the lives and wellbeing of the nation.

2.3.2 Carbon sequestration

Agroforestry can help address climate change and help increase our resilience to the hazard's climate change causes. Keeping excess carbon out of the atmosphere is a prime target for improving the health of our planet.

The World Bank has estimated that number of premature deaths in Thailand's population caused by exposure to air pollution at levels above current guidelines of air quality results in around 50,000 early deaths per year (Greenpeace Southeast Asia, 2018). It undoubtedly true that there has been increased awareness on this important issue for over the last two years through Thai population in handling the situation of $PM_{2.5}$ covering Bangkok and elsewhere. Especially, the current serious toxic pollution was caused by the bushfire, has reached a dangerous tipping point in

Chiang Mai, Northern of Thailand. The aftermath of the forest fire causes the smoky air and become serious on health effects on the long-term and it affects the economy and the government for the costs of treating for patients from this pollution.

Moreover, the agricultural activities related to greenhouse gas emissions, such as methane creation from rice fields and livestock areas, collecting carbon in plants and soil through grazing and soil improvement by using organic materials with high carbon values especially burning crop residues in cultivated areas, these all have a complex role for creating global warming and a source of carbon.

Whilst, the world facing many crises which climate change is one of the problems related to the amount of carbon dioxide in the air. Many innovative companies began to planned on research development on processing of technology uses that providing option for sequestering carbon and transformation into facilities for any uses.

It reveals that some agroforestry systems, in particular, have the ability to enhance the resilience of the system for coping with a climate change mitigation actions through carbon sequestration (Murthy et al., 2013). It is proposed that, if developed on a sufficient scale, agroforestry systems (AFSs) have the potential to significantly and cost-effectively contribute to Thailand's carbon sequestration and help address climate action objectives through helping decrease atmospheric carbon dioxide concentrations, which in turn will lead to enhancing the lives and wellbeing of the nation. These processes:

1) are often create reservoirs of carbon that are stored as biomass in tree trunks, roots and soils and mitigate greenhouse gas or climate change on agricultural land (Schoeneberger, 2009);

2) green plants are able to reduce CO_2 concentration levels through photosynthesis and store it as its food source (Schahczenski and Hill, 2009) which is absorbed and can be released through the rotting roots or wood decay. It is considered as a Forest Carbon Cycle and also as a forest emission through the respiration of forests, become a microbe from rotting plant and nitrous oxide gas that release from forest soil.

It has been estimated by Nair et al., (2010) that the amount of carbon stored by agroforestry per hectare per year ranges from 0.29-15.21 tonnes above ground level and between 30–300 tonnes at up to a meter's depth into the ground.

It has also been estimated that worldwide approximately 630 million hectares of land [3,937 million rai] could be used for agroforestry (Jose & Bardhan, 2012), as with the majority of new tree-planting, this much substantial due to storing more carbon in the wood biomass.

With regards to the world's regions, Southeast Asia is recognised as having the largest biomass carbon stock (per hectare) for agricultural land. In 2000, it had 60 tonnes of carbon per hectare in 2000, a figure which increased to 65 tonnes per hectare a decade later (Zomer et al., 2016).

2.3.3 Effectiveness of agroforestry as a carbon sink

The proper design and management of agroforestry systems may result in increased carbon sink potential depending in part on the land-use system which it is replacing. This is primary related to its original condition, biodiversity levels, whether it is primary or secondary forests, and the amount of carbon in standing biomass and wood products. If agroforestry is undertaken on land that was previously without trees, or otherwise degraded, it can beneficially increase the area's carbon sequestration (Montagnini et al., 2004).

In actual practice, there are some of the agroforestry practices commonly used elsewhere in the world which can be adapted and established with appropriate implementation of agroforestry systems in Thailand. There are several categories of agroforest practices which can further boost carbon storage which are listed below:

Table 2.9 Categories of agroforest practices

Categories	Description
Alley Cropping/ Alley Crop/ Intercropping	Defined as a simple system of planting crop rows or creating strips of trees and other crops in the alleyways within which agriculture crops grow.
Windbreaks / Shelterbelts (Recent Agroforestry Systems from North America):	Established for environmental purposes to protect livestock and reduce animal stress, shield buildings and roads by reducing wind speed and controlling soil wind erosion. These also provide economic returns and benefits to the land owners (Dagar and Tewari, 2017).
Riparian forest buffers	Primarily for ecological services and urban settings established on the wetlands. It contains a combination of trees and other perennial plants for produce as harvesting plants along with the conservation benefits and enhanced water quality by natural filtration.
Silvopastoral systems/ Silvopasture	A deliberate process that integrates the grazing of livestock with the production of forage crops on the same agricultural land, with timber trees being produced as additional commodities (Elevitch and Wilkinson, 2000). This system can help reduce heat-stress which improves animal well-being and enable them to enjoy the benefits of shelter and shade whilst helping manage weed control.
Forest farming/ Multi-storied cropping/ Home Gardening	Cultivation of high-value or specialty plants under a forest canopy, such as medicinal herbs, mushrooms, ornamental plants, and decorative ferns that are later sold. This system, which is commonly developed by small farmers, provides a double advantage. It helps withstand shading effects, improves the microclimate conditions in relation to crop production, and meets the local demand of food, sources of timber, firewood, and fodder for meat and dairy cattle (FAO, 2013).
Woodlots	A productive planted forest serving to rehabilitate degraded land while providing a timber or firewood products for use (Elevitch and Wilkinson, 2000).
Reforestation	Replanting trees on areas that were once forests in order to aid carbon capture, reduce soil loss, and aid local economies (PUR Project, 2016).

Source: National Agroforestry Center, USDA; Schoeneberger, (2009).

Research on agroforestry's potential to store carbon on Nebraska farmland by Schoeneberger, (2009), indicated that field windbreaks planted on 5% of the area available for planting stored CO_2 11.7-23.4 million metric tons (MMT) in 20 years and around 23.4-46.8 million metric tons (MMT) in 40 years. In comparison, riparian forest buffer storage amounts to around 9.2-18.4 MMT within 20 years and 18.4-36.8 MMT within 40 years (Schoeneberger, 2009). Whilst, the U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks has announced data on carbon sinks in

agricultural activities, 1990 – 2005 for which Agricultural Soil creates around 157.4 million metric tons CO_2 equivalent.

With a higher potential for carbon sequestration than other land-use and management options, Catacutan et al. (2017) claimed that agroforestry is able to capture more than 550 MMT of carbon per year. These can be designed and managed to provide a variety of produce and services, including indirectly helping reduce the pressure on natural forests which are the largest sink of terrestrial carbon (Nair, 2009). In other words, the creation of further agroforestry initiatives can help: prevent the eradication of existing forests; protect water quality; mitigate greenhouse gasses; aid climate change adaptation; aid biodiversity; and provide other system services. Regenerative Agroforestry can be a solution to help mitigate the climate change as it can remove a significant amount of GHGs.

2.3.4 How agroforestry helps increase farmers' income

In support of this, a study by Bolivia's Research Institute of Organic Agriculture (FIBL) assessed that young cacao agroforestry practices can be more profitable and provide higher return on labour compared to monocultures under conventional management. In terms of a systems comparison, the agroforestry systems have a higher diversification of crops and the working time was also higher due to the harvesting of the banana crops and the pruning of shade tree management which are both highly labour intensive activities. Moreover, organic land area has increased to 10 million hectares to help meet the growing demands for cacao (Research Institute of Organic Agriculture (FiBL), 2017; Armengot et al., 2016). Cacao plants are also grown within Thailand and are easy to look after as they are flood and drought resistant (WWF, 2019).

It has been calculated for Sumatra, Indonesia, that converting from a monocultural 'sun coffee' plantation system to a 'shade coffee' system, with the inclusion of shade trees, improved average landscape carbon stock by 10 tonnes of carbon per hectare over a two-decade period (Van Noordwijk et al., 2002). Other plants like coffee crops production in agroforestry systems, fruit and timber trees are considered to be the most important shade tolerant cash crops. They can be significant

cash crops for producing and consuming countries (which are grown for sale and export), unlike food crops which are grown only for consumption.

Thailand is a world-leader in producing natural rubber which is mainly produced by smallholders. During the midst of fluctuating prices which directly impacted farmers' income during 2010-2015, a number of farmers in Phatthalung Province in southern Thailand used the concept of agroforestry systems with shade tolerance in planting fruit and timber trees in association with rubber and also participated in off-farm activities. This measure, which is still seen as a novelty practice in southern Thailand, greatly helped improve farmers' resilience and ability to deal with rubber prices volatility. Moreover, Penot et al. (2016) claimed that farmers who chose to grow fruit trees as part of this practice also did so to help feed their families, guests and visitors, and to let them make gifts of fruit to others within rural locations has high social value.

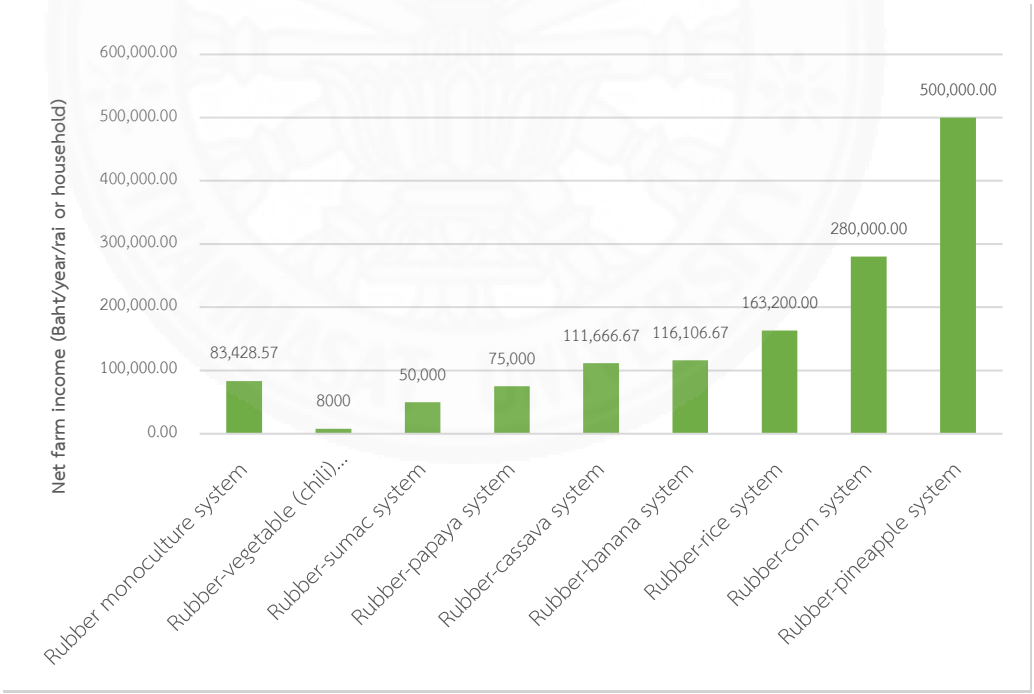


Figure 2.10 Smallholder Rubber Agroforestry System (SRAS) combination

Source: Adapted from Somboonsuke et al., (2011).

A number of studies indicate that agroforestry can be more profitable to farmers for an area of their land, in terms of crop income, than agriculture or forestry alone (Fanish & Priya, 2013). Research by Somboonsuke et al. (2011) indicates the substantial degrees to which Thai farmers can increase their agricultural incomes through correctly adopting the principles of agroforestry and choosing the best combinations of crops. As shown in Figure 2.10, the levels of income that can be gained are dependent in part on the crops raised. From the examples provided, it can be seen that in the best instance, the net farm income (from growing combined crops of rubber and pineapple) was around six times greater than that provided by the rubber monoculture system.

2.3.5 Agroforestry, food security and poverty reduction

As noted by Research Institute of Organic Agriculture (FiBL) (2017): “Agroforestry offers more income, food security and biodiversity”. However, the problems of food security resultant from climate change and environmental degradation that focuses on producing food at high price and have poor access. It created a challenge, especially for developing countries which must create countermeasures for the survival of their populations.

Thailand has a far better landscape for producing and exporting food than many countries, in other words, Food and Agriculture Organization of the United Nations found that some Thai population are classified as Undernourished people and the natural base continued erosion damage and deterioration, including the problem of foreigners relying on the gap of laws to occupy on agricultural land which causes loss of land use and agricultural labour shortages (Changon, 2014). To achieve global food security, many countries have initiated the concept “to secure adequate and suitable supply of food for everyone” by delivering excess food to needy countries and changed into “Food for development” which support self-sufficiency in each country.

Food security covers multiple social dimensions and environment goals. Therefore, FAO defined the meaning of food security as a condition in which everyone has both physical and economic capability with food access and availability,

food utilization and stability (FAO, 2006), safe and nutritious in order to increase satisfaction and health achieve.

Also, become more resilient to any insecurity in several likely condition's effects and unpredictability. Agriculture options as agroforestry can increases crop resilience to many changes because it has ability to enhance water infiltration and storage while reducing evaporation and temperature extremes (Charles, Munishi, & Nzunda, 2013; Garrity et al., 2010; Waldron, 2017). It also can also help to give farmers a big lift out of poverty by increasing their yields with low cost farm-based products, that are mainly tree-related, that can significantly increase the net income of their farms (Miller et al., 2017; Reyes et al., 2005; Waldron et al., 2012; Waldron et al., 2017).

When the world's biggest problems are not just the agriculture facing the challenges in the 21st century in both adapting to climate change or handling the world population that will reach to 9 billion people as global demand in 2050, which will make urban society (Urbanization) leads to 60% increase in food demand (FAO, 2016, 13 p.) and a small rural labour force need foods to sustain life longer.

With the continuing pandemic threat of COVID-19, which was first identified in Wuhan, China last year, there has been a significant impact on global health (WHO, 2020). The agriculture world has been turned upside down, leading to compromised domestic and international transportation of goods resulting in considerable disruptions and waste.

Governments around the globe have cancelled travel due to COVID-19, which has had unintended consequences on migrant labour, which in many areas acts as the main workforce for producing food. In many key food making nations, visa restrictions for migrant farmworkers are causing labour shortages in some sectors (Bloomberg, 2020). The pandemic has exposed areas of vulnerability within the supply chain. Agriculture in many sectors has been severely affected by this new coronavirus outbreak. and nutrition security for livelihood on both supply and demand and possible effects on food prices, trade of agricultural products and market chains (Martin, 2020).

Such matters have made many countries, and large companies, pay greater attention to agricultural development and food investment. Although Thailand already produces substantial quantities of agricultural products, the country must become more resilient to global change, and use the concept of business economy that promotes agricultural personnel with greater in implementing, to support and prepare for every situation.

2.4 Permaculture

Permaculture can be defined as the word “the conscious design system for sustainable food production and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems”, coined by Bill Mollison. Permaculture, or as it is also known, ‘Permanent Agriculture’, brings together science, art, and philosophy, and in its simplest form introduces the practices, processes and principles of designing agricultural systems to take into account and work with the diversities and stabilities found within the ecosystem (Marukatat, 2019). Also, it provides a harmonious amalgamation between the outdoor world and human needs for food, shelter and protection.

The practice of permaculture on farms is undertaken by both small and medium-scale farmers and aims to minimise inputs whilst increasing outputs. It links ecology and culture, and promotes viable farming communities in tandem with high added value (Andeyo, 2018). Examples of this are communities living in the midst of nature, growing vegetables and cultivating food gardens, where members of the neighbourhoods help support each other. They represent “the traditional farming community” and the traditions they continue have been passed on through the generations along with the local wisdom of their ancient Thai ancestors.

Whether it is the gable roof of buildings having a steep slope, as a result of ancient Thai wisdom that enough to let rainwater system and suitable for the weather, basement flooding and prevent pest infestations. Also, it is familiar that organic has definition as a food using natural matter produce in farming system but it is an undeniable fact that organic food was obtained depends on each area and the

appropriate factors. If the production and lifestyle always change and the path of sustainability in the past gradually fade away from the lives of Thai people without record inherited knowledge traditions, it is not be able to preserve the original wisdom for the future generations. Many communities have already applied their knowledge to local development and contribute to quality education related to this. As 'Permaculture Design' or 'Permanent Agriculture' context, case studies that convey the concepts of permaculture undertaken through educational institutions are briefly discussed below:

2.4.1 Educational institutions

2.4.1.1 UMASS Permaculture, University of Massachusetts

Food production initiatives can be undertaken in both rural and urban areas. The sustainable permaculture gardens at the University of Massachusetts are one example of an initiative by UMASS Permaculture. It began with sheet mulching the entire 1,115 square metres of its gardens to generate nutrients within the soil. This type of practice is also known as lasagna gardening with no-till gardening to produce and prepare garden beds for organic planting. This practice can build remarkable soil improvement and weed removal in a few years (Toensmeier, (n.d.)).

It is critical to those wishing education on matters related to food and soil growing, working with water in the landscape, and maintaining all of our human systems. Such initiatives, particularly if widespread, can make a huge impact on how a country runs and the overall health of people. They also help to avoid detrimental environmental impacts being created (Gerber, 2013). Many students and volunteer staff joined the design implementation phases, changing unproductive space into green space that is thriving and sustainable and an educational resource for the campus and local community. Also, through this initiative, local community organisations and schools can get a better idea of what is achievable and mimic it in other places. The awareness and participation that comes with students growing their own food helps them to recognise that they can do something to help address world issues by revitalising unproductive ecosystems, starting to strengthen their local communities, and making businesses or entire lifestyles more sustainable.

2.4.1.2 The Permaculture Institute of Thailand

Howard Story is an instructor in urban sustainability, resilient village design, and food sovereignty. He is also a social entrepreneur and founder CEO of the Permaculture Institute of Thailand, an organisation that teaches farmers, including smallholders living in poor rural communities, about how to increase their income through permaculture. The main benefits of this institution are that it helps people identify the long-term consequences of actions they undertake on how we live and how the next generation lives, and how committed individuals can make things better for themselves and others.

The main point of his education initiative is the creation of resilient sustainable villages. The Permaculture Institute of Thailand not only educates local farmers; it also educates young people from around the world who come to Asia. It does this in a very cost-effective manner, using a lower level of resources than would be normal for such aims, teaching natural building techniques, letting people learn aquaculture and permaculture hands-on through sustainable methods that are taught and practiced by 200 host farm families. The chief benefits of this approach are the application and generation of sustainability skills and innovation achieved through a hands-on approach that encourages learning by doing (Story, 2017).

2.4.1.3 Rak Tamachart Institute Thailand (Korat Province)

The Rak Tamachat Permaculture and Education Institute in Thailand offers individuals, most of whom are foreigners, opportunities to take - both online and onsite - permaculture design and sustainable education courses through its ecovillage community which promotes sustainable lifestyles. Its permaculture projects range from: learning to make compost; worm farming; seed saving; and making biochar [a carbon-rich material produced from biomass or agricultural waste material (rice straw, corncob and cassava rhizome)] and charcoal; harvesting ginger; plant propagation; and cutting and potting. Additionally, organic techniques are taught that can enable participants to make their own organic liquid fertilisers. Its principles and guiding actions show that transitioning from monoculture to sustainable permaculture is both possible and desirable (Rak Tamachat, (n.d.)).

2.4.2 Thinking smarter example: comparison of different traction power sources for farming

With smart farming the emphasis is often on adopting high-tech solutions to address everyday farming challenges. With smarter farming, the emphasis is on achieving the best solutions on a case-by-case basis, often by challenging conventional ways of thought to do so. Sometimes this indicates that low-tech solutions can provide superior results to their high-tech alternatives, or that low-tech can be successfully used in conjunction with more high-tech approaches. A farm management system in which animals create complementary biodiversity within an agricultural ecosystem can often be easily created. As examples:

2.4.2.1 Draft animal selection

An example of the use / upgrading of traditional farming techniques instead of newer alternatives is found with regards to the use of draft animals, such as water buffalo and oxen, instead of tractors by smallholder farmers. It has additionally been noted by Taylor (2011) that "Some young farmers are developing a hybrid practice, using oxen to supplement, rather than replace, tractors." The following are among the benefits that can be obtained from using draft animals on smallholdings: The hooves of draft animals aerate the soil as they move about, allowing the earth to retain its fertile microbial layers which could otherwise get damaged by tractor use which can cause deep ruts in the soil; free fertilizer is left behind as a byproduct when the animals relieve themselves; draft animals are typically cheaper to run and maintain than tractors that require fossil fuels (Taylor, 2011).

With regards to the economic importance of draft animals to smallholder farmers, Teweldmehidin & Conroy (2010), as part of their research conducted in Africa, noted that "the use of animal power performs better in terms of physical productivity per ha compared to tractor usage". Conventional tractors can be more expensive to maintain than animals performing the same duties as tractors.

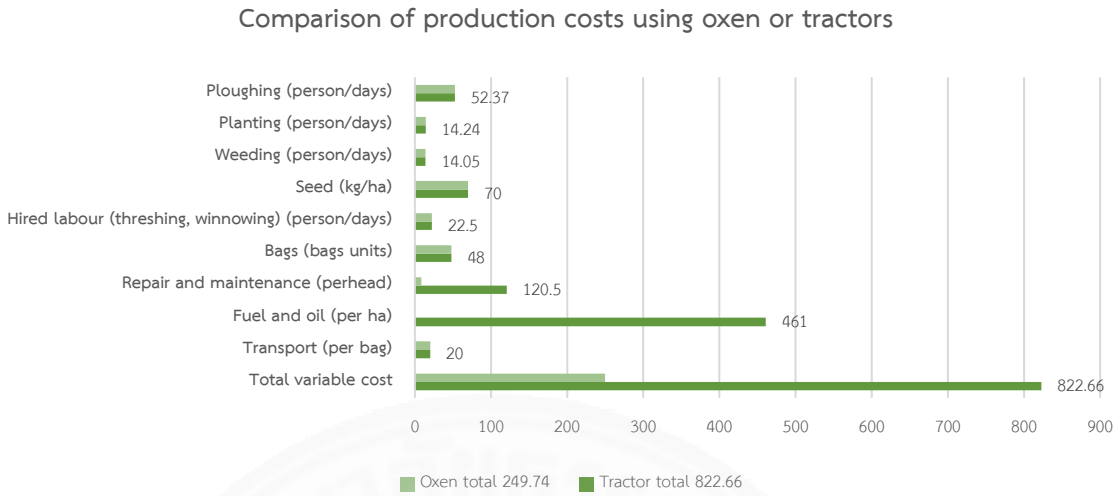


Figure 2.11 Comparison of production costs using oxen and tractors
Source: Adapted from Teweldmehidin & Conroy, (2010).

Draft animals can provide substantial benefits to farming and can be benefit all member of farming community but still require expertise who have experience and know what can be used for adaption of tractor-based equipment (Mumma, T., 2008). Additionally, animal husbandry along with the above measures can enhance the local economy, production and consumption in nearby communities, and help eliminate the poverty.

It has also been observed that adding draft animals to farming operations can help generate beneficial publicity and goodwill towards a farm which can provide opportunities to help create profitable agricultural tourism (agri-tourism) and more memorable farming experiences for members of the public. As noted by Collins (2013): “I’ll wager that few farmers have ever seen people stopping to watch a tractor work, but oxen just seem to draw a crowd. If your small farm plan includes public events, a team of oxen may generate enough additional interest to justify their effort.” Similarly, it has been noted by Truong et al. (n.d.) that the buffalo van, a trailer pulled by a water buffalo, was recognised and appreciated as an amazing means of transport by those learning about sustainability whilst staying at an organic farm in Vietnam. The use of farm animals can add a layer of charm and enchantment to the

farming business, and as demonstrated above in Figure 2.11, it can also make strong financial sense.

2.4.2.2 Encouraging Animal Eco-System Services

Fire Risk Reduction is Forest fires can cause devastating losses and are likely to become ever more common in many areas of the world, particularly as a result of climate change. Surprisingly to many, teams of hungry goats can be used as an efficient ecologically friendly method of removing fire-prone or dry vegetation like oak brush (Kiester, 2001; Clark, 2009; Lawton, 2014).

As an example of this, in Anaheim, a city in California, USA, around 400 goats are now used to help prevent wildfires. They are now employed to graze on hillsides around the city for most of the year. The goats eat the dried brush and invasive grasses on those areas, helping reduce the fuel load for potential wildfire events. The removal of the invasive plants by the goats also helps with the re-establishment of native plants to enhance the local eco-system (Manata, 2020). A further example is provided in Spain where a pilot program using "Goat Fire Brigades" is being used to reduce fire risk and water use to help save money (Miller-Crispe, M., 2011).

With regard to Pest Control, another example of the organic approach is the use of chickens or poultry in an animal tractor (a moveable enclosure with an open base) to prepare garden beds and undertake pest control. Ducks can also provide natural pest control in vegetable gardens and leave their manure as organic plant food (Liu, 2016). "You don't have a snail problem, you've got a duck deficiency!" is one of Mollison's famous quotes in the book *Introduction to Permaculture (1991/2009)* that land, water, plants, humans and wildlife can co-exist in harmony and animal are essential for the regulation of pests, maintenance of soil fertility, and nutrient cycling of a farm.

Integrated aquaculture is another measure that can be taken up and is a form of sequential linkage with farm activities and fish-livestock which can be undertaken to help develop the potential for farms' productivity, reduce the shortage of foods containing protein, and generate income through the efficient use of natural resources.

Weed Control, animal grazing can provide a great opportunity for the sustainable organic control of weeds (Pesticide Action Network Europe, 2017). It can also be used to improve the soil quality and fertility without chemical use. Some organic farmers let pigs loose in their fields to act as natural cultivators that root up weeds that have grown over the season. This method has traditionally been used to make agricultural systems more resilient and persistent weeds much slower to return (Wilmoth, 2015; University of Florida Institute of Food and Agricultural Science, 2015).

Animals can provide a wide range of diverse products and services: manure-providers, pollination, forage and habitat enhancement. Pigs and poultry can as diggers to increase soil quality, goats can be first responders for clearing areas through their grazing to improve fire control, and mussels can be used to help cleansing coastal waters. Permaculture is not just an agriculture system; it is a land design principle which is mostly used in agricultural farming and can also be applied in urban design. It can enhance areas without the use of artificial pesticides and fertilizers through using composted food and animal droppings as fertilizers, working in harmony with the soil and microbes in a closed cycle ecosystem.

2.5 The open cluster development model

2.5.1 Dr. Krirk Meemungkit, Thai Smart farmer

“Agriculture is not a theory that you just watch and do, it is one where you gain experience and practice.” So says Dr. Krirk Meemungkit, an award-winning agriculturist, and retired professor, who considers agriculture the most important profession in Thailand and the world. The examples of products that produced from integrated farming and income from thinking and production by things around which begins by collects cutting wood from the side of rural roads, gardens and drying out the moisture from it. Which the smoke will condense into wood vinegar, the natural organic product from agriculture and also obtained charcoal from burning as a renewable energy.

Another aspect that Dr. Meemungkit has recognised from his farming business is that the government should encourage other farmers or people to burn charcoal or what is already cuttings.

The main point is encouraging people to plant trees in their own place that can increase the amount of vegetation in the area and that also wood vinegar and charcoal can be created as goods for use in Thailand and for export. Planting more trees results in more carbon capture. His work includes not only agroforestry, creating charcoal and wood vinegar, he sweeps the leaves into compost, makes organic fertilizer and plants seedlings. These other actions also generate income and add additional benefits.

Among the befits created by adopting such approaches are that "Charcoal made from wood vinegar produces cleaner, safer smoke," and that diluted raw wood vinegar can be used to: kill pests and weeds; prevent pant lice, pests and mold; prevent stems and roots rotting; and enhance fruit growth (Princess Sirindhorn's Projects (n.d.)).

"The main problem of farmers is not just poverty, but that when they are free, they are not thinking or do anything which will avoid creating more poverty traps," Dr. Meemungkit says. In terms of approaching agriculture as a business, planning for long-term consequences is the starting point of success in the business process, along with planning what to do and how to make money initially. Then continue with the medium-term plan which is to cultivate to prepare for the next planting and animal husbandry and food production for the long-term, as well as being able to process things and generate income in the future (Meemungkit, 2017).

It is important to note that Dr. Meemungkit earns more than many city workers, whilst having a far less stressful life. He also does less work than them. He has other people pick the crops that he grows and they pay him for the foods they harvest.

The Tree Bank Project, for which Dr. Meemungkit is now the Branch Manager for the Srakaew Province, is an independent civil society organisation that encourages farmers to plant trees in agricultural areas and obtain the benefit from the timber they provide, to enhance the natural landscape, improve the soil and stimulate financial and material growth through adding valuable assets to the land. This approach has spread across Thailand and youth are also invited to come and learn about how to establish community-based forest enterprises. This innovation volunteer organisation aims to be able to increase social and real return on investment for small landholders and enable them to realise the financial potential in tree planting as a way to invest for future and invest in the future (Dahlstrom, (n.d.); Meemungkit, (n.d.)).

2.5.2 The Smiling Gecko model for financial independence

This concept of self-sustaining rural development is already being championed in Cambodia by Smiling Gecko, a non-profit organisation led by international philanthropist Dr. Hannes Schmid. Its chief motivation is to empower people so they can lead better, more worthwhile, lives. The approach it has adopted actively addresses the agricultural challenges found within this new organic community, often by obtaining specialist advice from international experts. It has also chosen to create other forms of local employment and training within its business model, and sustainably expand on them as time progresses.

It has additionally factored in the need to provide good education and nutrition to the children in the area it is based. In its initial cluster model, started in 2014, it focused primarily on agriculture and education. This model later expanded in 2016 to include craft and tourism, then expanded again in 2018 to include industry and medical provision. It is intended that the project will soon be entirely self-funding. Smiling Gecko predicts that its business model for rural areas can be expanded still further and applied in other parts of that country to help support local job initiatives and promote self-help (Smiling Gecko, 2019; Liechtenstein Dialogue for Development, 2018).

Dr. Hannes Schmid is the world-renowned social entrepreneur and internationally famous photographer who founded Smiling Gecko Cambodia in 2014. His journey into large scale philanthropy initially started in Thailand as a result of

meeting a young badly disfigured Cambodian girl who was begging in the street and wanting to know more about what had led to the challenges she faced. He provided the opportunities for her to start her journey to recovery and to live a more worthwhile life again, and began the Smiling Gecko project to helping thousands of Cambodian children through direct aid by giving them and their families the opportunities to have good quality lives.

Smiling Gecko is a non-profit organisation for which Dr. Schmid laid the foundation by buying a 120 hectares site to the north of Phnom Penh for a cluster project for poor families who had very low-income or faced poverty traps. As part of his enlightened approach, he invited experts from Switzerland to work with them to help solve the agricultural problems they faced in the new organic community he was creating and also received help from abroad to design the school buildings for children in the village to be educated. The organisation's chief motivation is to empower people so they can lead better more worthwhile lives.

Smiling Gecko's major objectives are as follows: Fighting hunger and poverty, School education and vocational training for young Cambodians, Community development, Economic development, and Protection of the environment.

The initial clusters of the its open cluster model are shown in Table 2.10, and contains agriculture and academic education within the first of its four clusters. Followed by Second cluster: Agriculture Family Project; Old Village School; Third cluster: Families; Students; Teachers; Fourth cluster: Children within the project and the region; Families in the Region; Guests and Clients from the region and overseas; Regional corporations; Families from the slums and the rubbish dumps.

Table 2.10 The development plan of Smiling Gecko's open cluster model

Years	Plans and aim	Smiling Gecko Principles	Helping purpose
2012	Creation as a non-profit organisation under Swiss law to benefit those in need and help empower them to become independent and reach their true potential.	Financing, and bringing together other kinds of support, including gathering expert knowledge. This is intended to ensure the success of helping people in need in Cambodia. Key projects are also sponsored.	
2014	Registered as a local NGO in Cambodia.	The main pillars of the open cluster model are; agriculture, craft, tourism and catering, and schooling and education.	Expanded as a holistic cluster project to promote the ability of rural people, support local job and self-help.
2015 - 2019	Expanding growth stages of the open cluster model.	Expanded to include: crafts, tourism, and medical provisions.	
2025	Focus on additional projects in the field of industry production and crafts.	Smart village created with a predicted population of 70-90 thousand people.	
2030	The UN's 2030 Agenda for Sustainable Development.	The open cluster model will start to be replicated in seven other locations and nine other locations in 2035.	
2050	Transferable to other regions as making a substantial contribution to the sustainable growth of the Cambodian economy by 2050.		

Sources: Smiling Gecko (2019); Liechtenstein Dialogue for Development, (2018).

Adhering to its undertaking of "Cambodians help Cambodians', the organisation provides direct aid to the disadvantaged, supports and helps create local job initiatives, and promotes self-help for those in the rural area (Hemschemeier, T., 2019). Its main mission is "to provide several thousand Cambodians with training and a regular income in the sectors of agriculture, tourism, industry, and trade." The income generated by those activities (Table 2.10) are intended to help fund the education of approximately 1,000 children that initiative will fully cover the running costs of the pre-school to senior high school. Eventually, it is planned that it will become completely self-sufficient (Smiling Gecko, 2019).

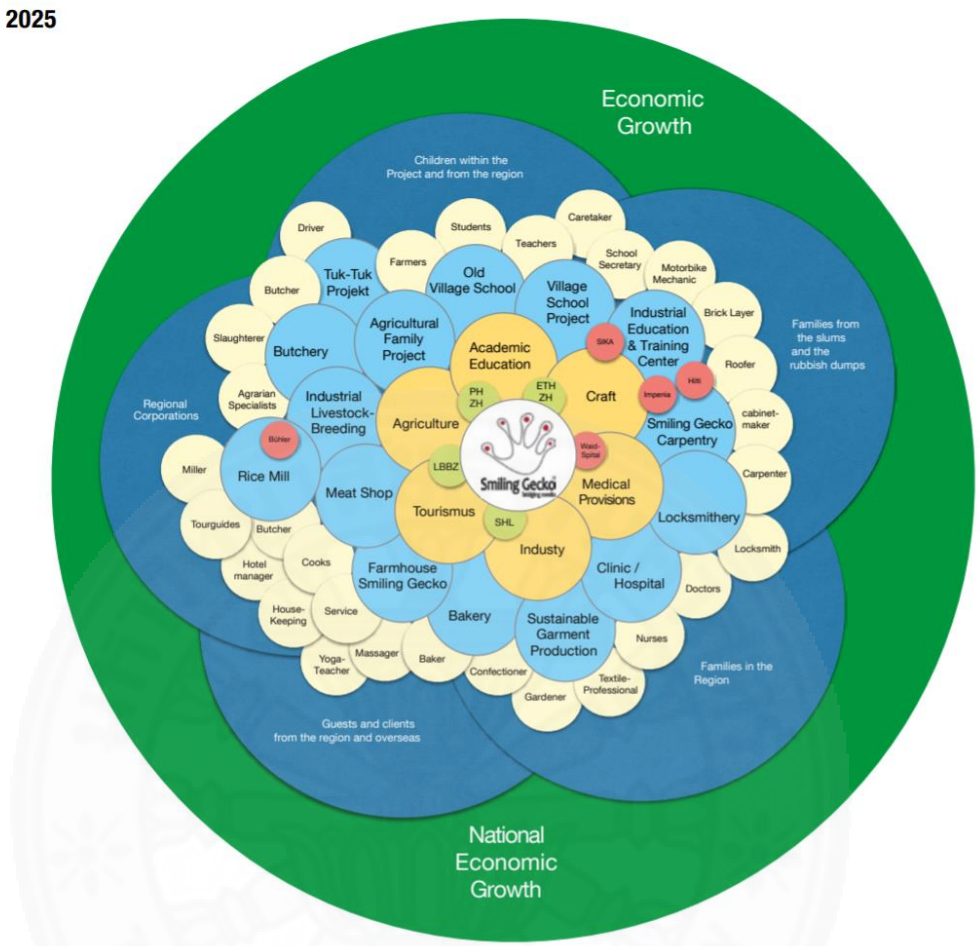


Figure 2.12 Predicted growth in the Smiling Gecko cluster project model

Source: Smiling Gecko (August 2019); Liechtenstein Dialogue for Development, (2018).

Furthermore, it has been commented on by Dr. Schmid that it has been calculated that by 2030 it will have duplicated its initial model seven times, as a result of being developed in other areas too, could produce 30 percent of the GDP of Cambodia with this system just by exchanging imports, or 80% into domestic production" (Liechtenstein Dialogue for Development, 2018).

With Smiling Gecko, the donations that are received are used directly on site. It should be noted that in recent years, its administrative costs have also been low. Its audited figures covering the period 2015-2018 are shown in Table 2.11.

Table 2.11 Revenues and expenses of Smiling Gecko Cambodia (In Swiss Francs)

	Year	2015	2016	2017	2018
Revenue	Donations	CHF 1,280,708 (43,121,046 Baht)	CHF 1,983,180 (66,773,063 Baht)	CHF 5,211,276 (175,462,066 Baht)	CHF 3,391,021 (114,174,638 Baht)
Expenses	Project expenses	CHF 710,304 (23,915,718 Baht)	CHF 2,002,312 (67,417,232 Baht)	CHF 3,104,341 (104,522,210 Baht)	CHF 4,081,916 (137,436,861 Baht)
	As % of donations	55.6	100.96	59.57	120.37
	Administrative costs	CHF 123,257 (4,150,025 Baht)	CHF 282,820 (9,522,463)	CHF 340,585 (11,467,393 Baht)	CHF 799,322 (26,912,926 Baht)
	As % of project expenses	17.35	14.2	10.97	19.58

Source: Information adapted from Hemschemeier, (2019).

It is foreseen that in the medium term the cluster will become self-financing and able to operate with external sources of funding. “Cluster projects thus create model rural communities that operate as self-sustained entities and offer education and training for gainful employment in proper jobs,” (Smiling Gecko, 2019).

2.6 The definitions of smart farmer

Smart people can be defined as those who are open-minded and willing to learn, adaptable to change, and have the ability to democratically contribute to knowledge. They try to view matters from a variety of angles to come up with the best solutions to make healthier environments and a better world and (Kumar et al., 2017).

There are differences in opinion as to what constitutes smart farming and smart farmers. The Food and Agriculture Organization (FAO) of the United Nations state that "smart farming" is a farming management concept using modern technology to increase the quantity and quality of agricultural products (FAO, 2017). It is suggested in this thesis, and also demonstrated within it by provision of practical examples, that high-tech approaches are not always required by smart farmers to improve the quality of their produce.

The Thai Ministry of Agriculture's perspective is that "smart farmers" are farmers who have a thorough knowledge of practical agriculture, and who take into consideration market demands, including the ability to produce solutions and solve any problems they come up against through the analysis of data: a component of decision-making based on principles and rationales (Ruthaichanok, J., 2018).

They are often more knowledgeable in specialist aspects of farming, typically possess a mindset that is adaptable to change, and take into account the need to sustainably produce their produce with high levels of efficiency. They are willing to transfer their knowledge and contribute to the next generation initiative that increases the application of science and technical knowledge into agricultural processes. This approach can influence and create opportunity for beneficial change (Ruthaichanok, J., 2018).

The definition of "Smarter farmers" used in this can be defined as farmers who are willing to learn, knowledgeable in agriculture, and take into account the need to sustainably provide high quality produce while ensuring consumer safety and environmental enrichment. In this context, the proposed SATI model is more inclusive than standard smart farming solutions and definitions which typically focus to a greater

degree on younger generation farmers, and high levels of investment in expensive technology.

It is proposed that smarter farmers that would operate using the SATI model are those prepared to learn from good knowledge whatever its source, and combine the findings of hard-earned wisdom and insights from themselves and others with cutting-edge knowledge, whenever appropriate, to create better solutions.

The SATI approach encourages everyone to be on a learning journey whatever their age and realise they are part of a larger community working together for the betterment of all.

'Smarter' is a mindset and a willingness to learn and share knowledge. It is a mindset that enables the growth of individuals and the communities around them. SATI encourages all members of farming communities to be, and act, smarter and realise that they have a voice and are able to contribute their ideas and suggestions to create beneficial change.

The model allows solutions, both high-tech and low-tech, to be tailored to individuals' abilities, and for such knowledge to be provided in ways that the smarter farmer can readily understand regardless of their prowess with modern technology. Given that the majority of the farming community is elderly, this approach appears particularly appropriate. Furthermore, the approaches that can provide the smarter farmer with better ways to do things can be customised to suit individuals' abilities and circumstances: "Teach a bird to fly, rather than teach it how to walk."

"Smarter farming" is an inclusive approach that brings together the concept of using both high and low-tech solutions, and old and new farming knowledge and techniques, to sustainably improve the quality and quantity of agricultural products produced whilst helping improve the livelihoods of farmers and farming communities and reducing risks. It is proposed that through this approach more revolutionary and more inclusive solutions can be found. Encouraging Thai farmers, of all ages, to become smarter organic farmers who can live in harmony with the land can help develop the progress and growth of the agricultural sector, help increase their productivity, the quality of their products, and help increase the life quality and wellbeing of themselves, their families and communities.

2.7 Sequence diagram

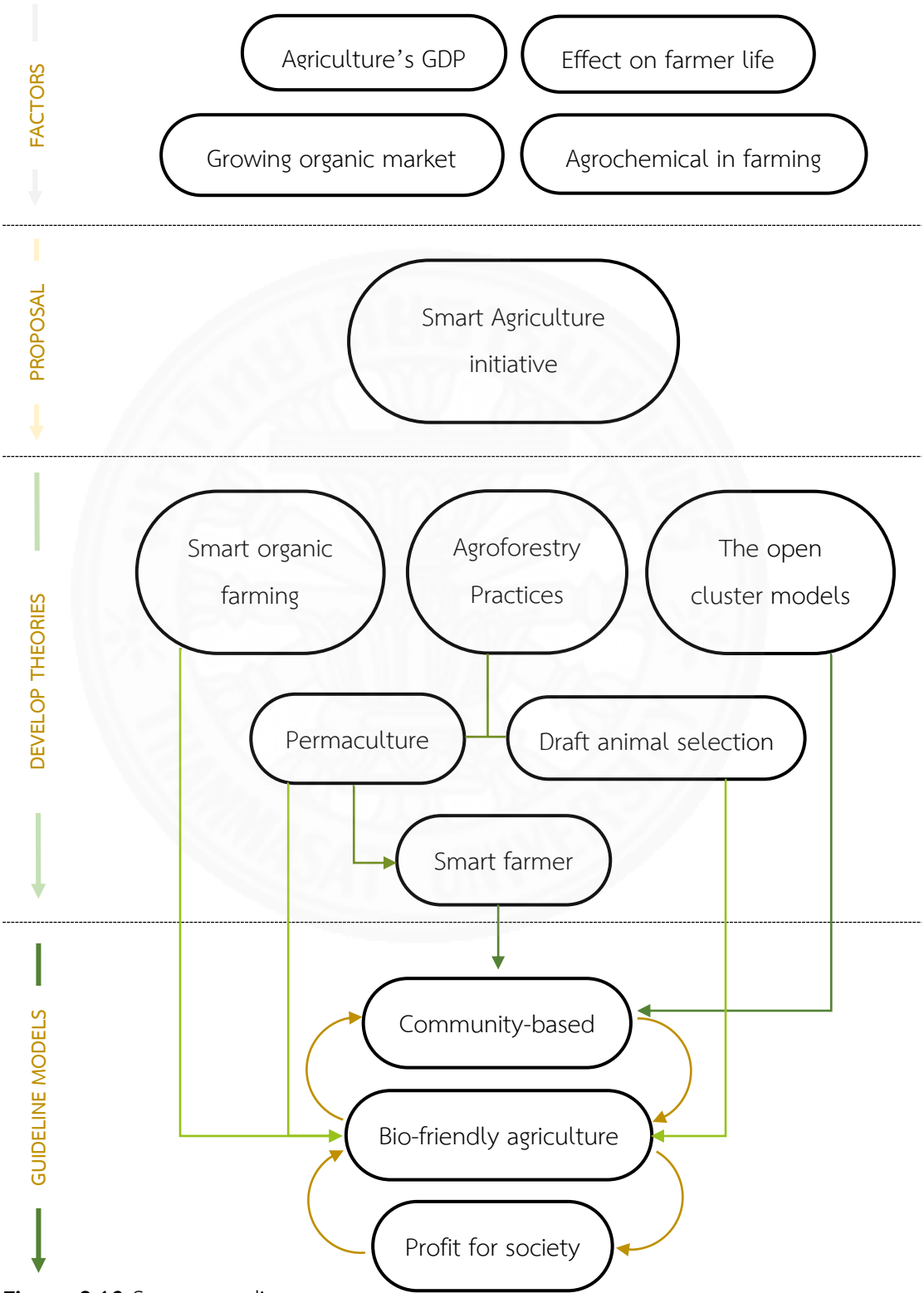


Figure 2.13 Sequence diagram

2.8 Guideline model and blueprint for SATI

2.8.1 Life-Quality-Community based: blueprint for creating smarter organic farming initiatives for Thai farmers

This targeted smarter approach offers the opportunity and co-creation for both high-tech and low-tech bio-friendly solutions to be developed to work in harmony with the best practice know-how, synergizes local initiatives and wisdom of previous generations, and brings communities together.

2.8.1.1 Addressing perceptions and preconceptions about elder generations, and realising the value that they can add

In the 21st century, most countries have standard retirement ages, generally ranging between 50 and 70. These retirement ages are continuing to rise and are designed to take life expectancy into account (International Comparison, 2019). However, as individuals' age many in society consider that their performance may often deteriorate alongside their physical condition. The richness of their experience and their potential wealth of knowledge are seldom considered.

Such preconceptions within society of their decay can lead to older people becoming marginalised and looked down upon. These attitudes lead them to experience ageism, age discrimination, and negative stereotyping (Khiewrord, 2016; Kassim, A. S. A. 2019), and can result in them receiving negative impacts from colleagues, employers and/or their family members. In addition to these experiences, there is a general assumption that older people lack an ability to learn new skills and to actively participate in the improvement of society (Ingkasit. R., 2020).

According to a report by the National Economic and Social Development Board (NESDB), Thailand is expected to become an ageing society by 2021. At that time, it is predicted that around 37.2 percent of the population will be aged between 70 and 79, and around 19.1 percent of the population will be aged 80 or over (Econ, 10 December 2017).

In Thailand, ageism is a serious issue that reflects and magnifies negative attitudes and values with stereotyping of older individuals. This is even apparent in most job descriptions, with stipulated age ranges for applicants often

excluding older individuals, and employers actively looking for younger people with appropriate levels of experience or specific skills. This situation is highly unfair and often actually precludes the best people for a job from being appointed. In comparison, most developing and developed countries have policies for employment expansion by hiring older workers with valuable abilities and skills in order to prevent their unemployment and help drive the growth of their domestic economies.

One way to co-create value for elders through social integration is by merging different groups through "multifunctional or multigenerational places". It may be used as a model for creating sustainable social communities and improved levels of equality and understanding. It can help reduce ageism, better support older individuals without upending their lives, enable them to be self-reliant longer, and enable them to live in harmony with society whilst still being thought worthwhile. As noted by Kiyota, E. (2018): "It is to everyone's advantage to unlock our elders' potential, making use of the wisdom and strength gained through their long-life experience."

2.8.1.2Local specialist farming knowledge and imported the specialist knowledge

Local specialist farming knowledge can bring especially good results. However, such knowledge has severely declined over the last decades. Most Thai farmers now use chemical farming methods, and because of this much local wisdom for taking care of plants and working in harmony with nature has virtually gone. It is often in part by listening to elders, or others from elsewhere still trained to know such things, that such knowledge can be reclaimed.

As an example of a smarter low-tech approach adopted with regards to the maintenance and harvesting of fruit trees, mention is made of the technique adopted by an organic farmer in Nakhon Ratchasima Province: all the durian trees at his farm are specially trimmed for particular ease of crop harvesting so there is not even the need for a ladder to collect the fruit (Auamnuaychai, N., 2019). Such knowledge can also be shared with farmers elsewhere.

The potential of technology, both high- and low-tech, knowledge sharing and innovation have assumed an important role and can make

impacts on every aspect of people's lives. Nowadays, farm people may often look to technology for solutions to many problems, and people use the chemical approach as a general method where the local wisdom in taking care of plants has all gone or severely declined (Auamnuaychai, N., 2019).

The smarter organic initiative approach can be able to help improve the quality of farmers' lives and guide them towards sustainable well-being through integrating information and insights on smarter organic farming principles. It is further intended that this approach be used to help create knowledge data bases for Thai farmers that they can easily access. It is further proposed that information from these be merged together and also customised as appropriate for local, national and international best practice data bases and knowledge hubs in the future.

2.8.1.3 Educating children and adults of all ages – the inclusive approach

"Education, ... is humanity's best hope and most effective means in the quest to achieve sustainable development" (UNESCO, 1997). The provision of equitable access to high quality lifelong learning can create tremendous benefits for people of all ages, backgrounds and learning abilities. It can also greatly help sustainability goals be achieved. Furthermore, past research reports that good education can enhance individuals' empathy and willingness to help each other, and that it can also help address sustainability goals.

There are a number of successful educational initiatives and education courses for schoolchildren being undertaken in many of the rural areas within Thailand and elsewhere around the world. These should be expanded upon to include other members of the community to in order to bring people together and increase the benefits that such initiatives can bring. As an example, it has been shown that access to knowledge on sustainability issues, best practice, and learning the benefits of working in closer harmony with nature, can help reduce risks, increase the productivity in the agricultural sector and help people to care more about the planet. It is best when people can gain first-hand experience of the beneficial changes that they themselves can create through "learning by doing" (Truong et al. (n.d.); Karshie

et al., 2017). Many such changes can often be easily achieved through proper education at all ages.

The SATI model's approach to education blends the best of high-tech and low-tech approaches and combines hard-earned wisdom and insights with cutting-edge knowledge. It encourages a growth mindset where participants are encouraged to believe in their own capacity, and that of others, to change for the better. With regard to farmers, it has been shown that there is a strong relationship between their awareness of particular practices and their participation in them. As observed by Karshie et al., (2017): "Farmers should be educated and enlightened on the importance and benefits …" of what is achievable. Active learning is encouraged. It is particularly important to help people learn in ways that are in harmony with their learning abilities and empower them, and that measures are taken to help appropriately address any biases that they may have that might otherwise hinder their progression. This includes showing how both high-tech and low-tech solutions can be used to create smarter solutions, and regularly asking them for feedback on what barriers need to be addressed and how they think things could be made better.

The Ministry of Natural Resources and Environment of Thailand (2017) has been implementing the Master Plan for Integrated Biodiversity Management (2015-2021) which aims by 2021 to drive sustainable management of biodiversity through participation at all levels. This may help to build cooperative networks to achieve the goals as its Measure 1 is: "Raise awareness and education by 2020, especially people and local communities to have a knowledge, understanding, and recognizing the importance of conservation and sustainable use of biodiversity". It is not only learning from generation to generation, but being able to drive development and expand in areas to add more value and become a strong community and develop sustainable growth that is important. The newer smarter solutions that are developed through this inclusive educational process can be incorporated into business models as appropriate.

2.8.2 Bio-friendly agriculture

In addition, biodiversity conservation and restoration through the actions of rural people or farming community involvement can contribute to

environmental protection, natural resource conservation, and poverty alleviation of poor people living in rural areas. Permaculture can be applied into everyday situations and the following techniques may provide an adoption-solution in integrating food security globally and promoting production for household consumption without the need for chemicals that affect the environment. The variability of the environment can often be addressed in part through the enhancement of biodiversity and also through bringing in high productivity and more sustainable practices that work in harmony with nature's principles.

2.8.2.1 Organic initiative: growing multiple types of crop can aid resilience and aid survive in harsher conditions

The Green Revolution in the 20th century was the most talked about change from traditional agroforestry to monocultures which refers to the forest planting of one crop which an extensive agricultural practice, and can result in long-term environmental deterioration, economically risk and become unutilized lands. Their harmful effects of pesticides and fertilizer causing crop disease resistance that unimproved, non-weather resistant, chemical contamination of soil, and drought condition. These are commonly referred to as land depletion, or 'agro-deforestation', which has been noted by Clarke and Thaman (1993) as producing high yields only in the short-term. Such activities can cause extensive environmental and social harm due to the inappropriate use of machinery and chemical farming methods. It can also cause the spread of diseases and insect pests.

With the population growth followed by the steep increases in demand for resource, it promotes the ensuring sustainability that aim to improve the resource efficiency in order to support livelihood and rely on nature. The agroforestry concept can be used to help restore destroyed ecosystems by help control water falling that fills to the surface or void of a soil and catchment water balance. Additionally, it more support on soil's fertility, protecting soil erosion and climate resilience in each planting area and increase a circular biodiversity. However, wide-scale agroforestry still has limitations with regard to its implementation, especially the lack of institution home and specific policies that could help support and encourage the adoption of this system (Catacutan et al., 2017).

2.8.2.2 Carbon sequestration

It was announced in a press release on 21 July 2020 that Bayer, the chemical, pharmaceutical and life science company, is "... to reward growers to generate carbon credits by adopting climate-smart practices and creating a new revenue stream on-farm" (Bayer, 2020).

A similar plan to help improve revenue streams through adopting methods that improve carbon sequestration has also been proposed for organic farming and organic agroforestry for the SATI model by Sisang et al., (2020). As mentioned earlier in this thesis, the extent to which carbon sequestration can be achieved through the adoption of organic farming and agroforestry can be higher than those achievable through chemical farming. It is proposed that in the SATI model further refinements to include agroforestry in development plans can boost local carbon sequestration by growing the right types of trees to cover the landscape. Because Thailand is located in the tropical wet and dry or savanna climate, most of its forests are broad-leaved forest. They have different characteristics depending on the rainfall they receive and different moisture levels. The forest can be classified into type of carbon storage: above ground and below ground, for which Hill Evergreen Forest has a higher carbon stock in above-ground storage at 20.94 tonnes per rai while Mangrove Forest can contain 6.21 tonnes per rai below ground.

Table 2.12 Carbon sequestration ability of each type of forest in Thailand

	Evergreen					Deciduous	
Type of forest	Hill Evergreen Forest	Moist Evergreen Forest	Dry Evergreen Forest	Mangrove Forest	Pine Forest	Mixed Deciduous Forest	Deciduous Dipterocarp Forest
Above-ground	20.94	20.08	18	13.22	7.22	15.62	6.48
Underground	4.58	6.10	5.23	6.21	1.95	4.54	1.81

Source: Department of National Parks, Wildlife and Plant Conservation (DNP), (2018).

2.8.2.3 Agroforestry

Smart Agroforestry Initiatives not only help to address CO_2, flood and drought issues, the adoption of agroforestry can be particularly important in providing growth opportunities for small-scale farmers and for land users at all levels. The adoption of agroforestry practices can enable individuals to undertake and provide a wider variety of products and services that can help improve their quality of life. Correctly undertaken, it can help strengthen the three pillars of sustainability: People, Planet and Profit and provide far more in terms of financial returns than the cultivation of traditional monoculture crops (Fanish & Priya, 2013). Agroforestry can act as a multifunctional system, where its format varies according to different cultural, environmental and socioeconomic conditions (Gender Team in Forestry, 2018).

Table 2.13 How agroforestry can address the triple bottom line of sustainability

	Agroforestry strives to optimise:
Cultural	- Raised productivity and diversity of production to help increase wellbeing and aid nutrition in rural areas. - Production of fuel source, fodder trees and other forest products saves time needed to source from elsewhere. - Offers labour opportunities for farmworkers when seasonal farm work is completed. - Maximises overall work output of individuals. - Helps maintain social bonds for those working in a shifting cultivation system.
Environmental benefits	- Provision of eco-system services: increased soil fertility, prevents soil erosion, restoration of damaged land. - Protection of crops and animals from wind. - Water quality enhancement and water conservation. - Aids biodiversity. - Provides mitigation for, and helps provide, adaptation to climate change.
Socioeconomic conditions	- Maintain or improve production and productivity of agricultural systems. - Diversified production of goods from forest: building materials, food, lumber, and wood fuel. - Provides the opportunities for smallholder forest-based enterprises. - Reduces poverty by supporting in-farm production and employment. - Reduces risk of economic failure by increasing diversity of production.

Source: Gender Team in Forestry, (2018).

Agroforestry can help substantially improve the quality of life of Thai farmers and create many other sustainability benefits. It can provide a more stable and more profitable income to farmers per unit area of land (Dagar and Tewari, 2017; Singh et al., 2018). It also provides benefits for the next generation, and can play a strategic role in helping countries to achieve the key national development goals related to poverty alleviation, food security, and environment sustainability (Catacutan et al., 2017; Buttoud, G., 2013).

In order to develop and push for greater implementation of guidelines on promoting education, transferring knowledge and raising awareness through communities, as well as maintaining and improving ecological balance, the pillars not only increase communities' capacity for self-reliance in terms of marketing and gaining financial security, they can guide financing community support and consideration for unconventional and innovative financial arrangements to add economic value within each community.

2.8.3 Business model for financial independence

2.8.3.1 The Smiling Gecko model for financial independence

To taking smarter organic farming initiatives a step further, an example of how farmers in South East Asian may obtain financial independence is provided in the philanthropic work of Dr. Hannes Schmid with regard to Smiling Gecko Cambodia. In alignment with Smiling Gecko's helping the people to help themselves philosophy, the organisation delivers direct aid to disadvantaged people, supports other NGOs and local job initiatives, and promotes self-help among the rural population through directly addressing the causes of poverty (Smiling Gecko, 2019).

All of the cluster projects have commercially viable business plans, with the intention that they be self-financing in the future and no longer require external funding. It is also intended that they will generate sufficient income to fund both the school and the education of the village's children (Hemschemeier, T., 2019). Smiling Gecko notes that its cluster project model approach is both scalable and transferrable to other territories. By 2025, it is predicted that the initial cluster will have increased in size to become a smart city to make it truly sustainable in its own right, with around 80,000-90,000 inhabitants.

Ways in which this can be achieved within a thriving organic farming community have already been successfully demonstrated over in Cambodia by Smiling Gecko (2019). In order to help ensure the survival of rural farming communities, it is important to ensure that the children living in such areas receive proper high-quality education and that the areas themselves become more attractive to encourage long-term investment and development and enable high-quality lifestyles. It is furthermore suggested that vocational training should also be planned in for school leavers in the new / revitalised rural communities that are being proposed for the Smarter Organic Farming Initiative for Thai Farmers being developed in this thesis along the lines already developed by Smiling Gecko (Smiling Gecko, 2019).

Hence, the proposed bio-friendly agriculture and community-based initiatives could be used to effectively define social and environmental related measurement scales or rating criteria, that could be incorporated with financial scales within a single matrix for a business model. Consequently, such a designed business model could be utilised as a tool providing the users with a new wider-ranging guideline that could also be applied in agile real-life situations which need to be adjusted in accordance with fluctuating market situations. This initiative includes enabling more informed consideration on whether to expand possible business ecosystems, which can be linked with employment through bio-friendly agriculture and related businesses, such as ecotourism.

CHAPTER 3
RESEARCH METHODOLOGY

This study was undertaken to investigate and gain better understanding of the lives, thoughts and perceptions of individuals living in rural farming communities, while developing a deeper understanding of those who undertake, or wish to undertake, more resilient integrated organic farming and agroforestry practices within such areas. It was also undertaken to understand how rural decline might be better addressed through adopting a novel integrated approach that has the capacity to reduce land degradation, overcome poverty, and help mitigate climate change.

To be more specific, it is involved obtaining a deeper understanding of: (a) people who already undertake such kinds of farming, (b) those who plan to convert; community groups that do organic farming and agroforestry; and (c) educational institutions engaging in permaculture.

3.1 Methodology selected

A qualitative research approach was undertaken in order to seek insights into the actual circumstances that exist and to gain a variety of perspectives (as outlined by Stake, E. R., 2010), as well as to provide a way forward to enhance and build agriculture initiatives that reduce the impacts of climate change, provide additional food and job security in farming, and build knowledge sharing community hubs for Thai farmers and others within rural communities.

A critical literature review was one part of the research process undertaken in order to organise topics and discoveries thematically and to form a more complete picture of the physical situation (Auamnuaychai, N., 2019). The findings from this were used to determine the questions to be asked through in-depth interview and farm visits, and also to aid scrutiny when collecting data by observation at the specifically selected farms discussed in Section 1. Moreover, the questions set seek to cover the obstacles, challenges and opportunities available while individuals start or continue

existing organic farming and agroforestry initiatives, and investigate how these might be improved still further.

Additionally, online tools were used to create a survey distributed via an online survey platform (Google Forms) as documented in Section 2 and spread through social media using Line and Facebook page. This was undertaken due to the compulsory COVID-19 lockdown in Thailand which meant that the survey work had to be continued online instead as a precautionary measure.

In order to select and compare the areas that are suitable for in-depth interview, rubrics were used as a scoring tool to create effectively planned assessment and evaluation criteria. It is a data analysis tool that can be used to improve and fulfil expectations. The ratings system indicating the degree to which the three pillars of sustainability can be developed within the SATI model are described in tables below.

Table 3.1 Rating criteria to which the "PEOPLE" pillar can be developed within the SATI model

	Scale Measurement				
	Life-quality-community based	**Non (<50%)**	**Neutral (50% - 75%)**	**Ability improves (75% - 85%)**	**Well-being (85% - 100%)**
People	Education (Tacit and Explicit knowledge)	Little or no knowledge education for children or adults.	Has learning groups. Standard curriculum for school age children. Limited in-work training with employers.	Knowledge sharing within the community. Adults as well as children are encouraged to learn and help teach others. This includes knowledge sharing within cluster groups and development of tourism.	Inclusive, self-reliant inter-related knowledge clusters. (Has smarter links with those outside community too). Teaches how to be ethical, live in harmony with nature, be financially independent, sustainable, innovative, and resilient from early age onwards. Provides knowledge and growth opportunities all ages. Includes specialist training through specific clusters. Training taken both in-situ and online with expert trainers.

Table 3.1 Rating criteria to which the "PEOPLE" pillar can be developed within the SATI model (Continue)

	Scale Measurement				
	Life-quality-community based	**Non (<50%)**	**Neutral (50% - 75%)**	**Ability improves (75% - 85%)**	**Well-being (85% - 100%)**
People	Social mobility: income distribution	Little or no income	Regular, but sometimes sporadic, income	Working with market forces and encouraging growth.	Working with green market forces. Businesses taught how to sustainably develop their assets while improving the life quality of their workers and the community. Social collectives created that encourage the "stronger together approach" whilst also encouraging individuals to be independent and discover their true destinies.
	Technology adaptation	Low-tech	Neutral	Hi-tech	The "you need two wings to fly" approach. SATI proposes that to create the best solutions you need to blend the best of Hi-tech and Low-tech approaches, and that individuals should be encouraged to use the best-practice approaches that they are comfortable with.

Table 3.2 Rating criteria to which the "PLANET" pillar can be developed within the SATI model

	Scale Measurement				
	Bio-friendly agriculture:	**Less (<50%)**	**Neutral (50% -75%)**	**Organic (75% - 85%)**	**Full green potential (85% - 100%)**
Planet	Multi-crops	Monoculture using chemicals	Multi-crops grown using chemicals	Crop-rotation and multi-crops.	Crop-rotation, multi-crops and intercropping. Choice of crops determined by (organic) market trends, and what is best for the area and the resilience of the community.
	Avoidance of harmful chemicals	Agrochemicals used, Hazardous to health and the environment.	Agrochemicals used in moderation. Reduced health effects.	Organic farming techniques used without need for chemicals.	Smarter non-chemical organic farming practices applied. Examples: Companion planting with other crops to avoid pests, encouraging pest-management and natural fertilizer provision by animals.
	Draft animal selection	No animals	Animals provide a source of income.	Have animal livestock and appropriate knowledge on how to best look after them.	Careful choice of animals (and how they are fed and managed) to help them provide valuable income and services, including acting as draft animals, pest reduction, and helping mitigate climate change.

Table 3.3 Rating criteria to which the "PROFIT" pillar can be developed within the SATI model

	SCALE MEASUREMENT				
	Impact on community:	**Negative**	**Neutral**	**Advancing**	**Net-Positive**
Profit	Investment	Lack of appropriate levels and types of investment. Lack of appropriate knowledge.	Able to starting investing. Investment with low level of capital. Some advice given by outside experts.	Increased investment, with long-term aims and objectives in mind. Appropriate use of capital. Increased input from experts, consultants and local stakeholders.	Appropriate use of individuals, techniques and technologies to enable both short and long-term profits and gains. Financial independence, with model generating surplus revenue to enable sustainable growth and development of clusters.
	Financial returns	Businesses may initially run at a loss during set-up and transition period. Debts may arise.	Able to manage and plan financial progress, with possibility of slow growth or remaining as is.	Working capital available for progressing business plans.	Working capital available for progressing business plans at intended rate of growth. Planning also made for possible contingencies as a safety measure in line with the late King's thinking with regard to resilience.

Table 3.4 Ratings criteria on how carbon emissions contribute to human and others

	SCALE MEASUREMENT				
	Impact on agriculture:	**Negative / Less turnover**	**Neutral**	**Clean**	**Net-Positive**
Carbon emissions	Carbon footprint from people	Electricity used for cooling and powering electrical items, Conventional agro-industry methods, Land use change, Land clearance (bio-mass burning), Use of Fertilisers and Chemicals.	Transportation and farm fuels sustainably sourced and produced, Controlled biomass burning, Agriculture operations.	Clean energy generation, Prevent contamination of water. Carbon footprint reduced by diversifying crop rotations. Carbon footprint lowered by increasing soil carbon sequestration.	Reducing waste generation and pollution, waste separation and management. On-site clean-energy generation. Integrate scientific agriculture practices to help reduce carbon footprint (Liu et al., 2016). Undertake measures to make agriculture and agroforestry carbon net-positive.

Table 3.5 Observation matrix of each organisation and its initiatives

	People				Planet						Profit	
	Education	Improve skills	Social mobility	Technology adaptation	Multi-crops	Draft animal selection	Agroforestry	Avoidance of chemical use	Carbon emission by animals	Carbon emission by plants	Investment	Financial returns
Ban Thungkraprong Community, Nakhon Nayok Province.	✓	✓	✓	N/A	✓	N/A	N/A	✓	N/A	N/A	✓	✓
Natural farming "Rai Na Pha Prasom", Banmaetam Sritha, Suphanburi Province.	✓	N/A	✓	N/A	✓	N/A	✓	✓	N/A	✓	N/A	N/A
The Mango House Farm, Khao Yai, Nakhon Ratchasima Province.	✓	✓	✓	✓	✓	N/A	✓	N/A	N/A	✓	✓	✓
Here Chai Rice Seed, Life and Spiritual Learning Center of Thai Farmers, Suphan Buri Province.	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Rak Tamachat Permaculture and Natural Building Education Center, Korat Province.	✓	✓	✓	N/A	✓	✓	N/A	✓	✓	N/A	N/A	✓
Permaculture Institute of Thailand, Buri Ram Province.	✓	✓	✓	N/A	✓	✓	✓	✓	✓	✓	N/A	✓

3.2 Study participants and research questions

3.2.1 In-depth interviews

a. Ban Thungkraprong Community, Nakhon Nayok Province, Thailand

b. Natural farming “Rai Na Pha Prasom” Banmaetam Sritha, Suphanburi Province, Thailand

c. The Mango House Farm, Khao Yai (Young Smart Farmer business owner), Thailand

d. Here Chai Rice Seed, Life and Spiritual Learning Center of Thai Farmers, Suphan Buri Province, Thailand

e. Rak Tamachat Permaculture and Natural Building Education Center, Korat Province, Thailand

f. Permaculture Institute of Thailand, Buri Ram Province, Thailand

It was intended that 12 people would be interviewed as part of the in-depth interview section of this work, with these interviews being undertaken at 6 different sites related to organic farming community, agroforestry farming, permaculture institution, and smart farming. However, the lockdown situation, which was initiated due to the COVID-19 pandemic, prevented a number of the planned face-to-face interviews being undertaken. As a result of this, only four people were able to participate in the in-depth interviews that took place during March – April, 2020.

The study area selected was chosen to enable focus on places where economic crops are planted, as well as business works undertaken, in order to plan for long-term community development.

Three out of four participants work here, with two of them being officers for it and the other is its owner. They all work closely with the Ministry of Agriculture and Cooperatives and have experience working with local farmers, this includes matters related to conventional chemical farming, different types of technology use for cultivation and processing and animal husbandry. They have experience of organic farming methods too. The center aims to become a learning center for all within its region.

The remaining participant works as a Head Barista and knows coffee farmers in the North of Thailand well. He has had the opportunity to bring other senior baristas to visit a coffee farm as a field trip in order to learn the coffee processing, and has experience with the production of coffee processing during coffee cultivation period.

It had additionally been intended that interviews would also take place at the Chai Rice Seed, Life and Spiritual Learning Center of Thai Farmers, which is one of the major tourist attractions in Suphan Buri Province. In particular those interviewees were to have been asked questions directly related to the three pillars of sustainability. Unfortunately, those interviews had to be cancelled as a result of the COVID-19 situation.

3.2.1.1 Questions used in the insight interview in Section 1

The questions that were asked varied between participants based on the types of position they hold, and the level of experience they possess. The separate sets of questions that were asked to them are documented below. The length of interview time for each individual was in part dependent on their availability.

1) Key Questions for Interviewee No. 1 (Officer at a Thai Farmers Learning Center in Suphan Buri Province).

2) Key Questions for Interviewee No. 2 (Officer at a Thai Farmers Learning Center in Suphan Buri Province).

3) Key Questions for Interviewee No. 3 (Owner of a Thai Farmers Learning Center in Suphan Buri Province).

4) Key Questions for Interviewee No. 4 (Head Barista at specialty coffee firm).

3.2.2 Online questionnaire in Section 2

As stated earlier, due to COVID-19 restrictions, an online questionnaire was deployed to gain further understanding of stakeholder behaviours as related to agricultural matters. This was run from 17th June 2020 to 28th July 2020. In addition to Part 1 of it asking general information on the respondents, the following questions were asked. The full online questionnaire that was created for this task can be viewed in the Appendix. The number of respondents to it was far lower than expected. This might in part be explained by the fact that many farmers are finding their circumstances particularly difficult just now, particularly as a result of labour shortages brought about by the pandemic, and also by the fact that many farmers often have little access to the technology and lack of assistance necessary to complete the questionnaire.

1) General information
2) Main questions asked about agricultural matters.
3) Specific questions for those interested or planning to do agriculture.
4) Respondents were then asked what their considerations and suggestions would be if they were creating their own smarter organic farming community hub.

In order to have farming communities that undertake smarter organic farming and agroforestry initiatives thrive rather than just survive, it is necessary to grow worthwhile communities for them to live in; economically viable smarter communities that will encourage people to stay where they are because of the quality of life and opportunities they provide. Such initiatives will also help reduce pressures on existing cities that are experiencing influxes of people from rural areas. The SATI model intends to provide a more rounded approach to what can be achieved that brings together the best of what all generations can offer.

A critical overview has been made between models indicating how each performs on a variety of factors related to the three pillars of community and to create a new theory of rural sustainability suitable for the Thai context. SATI encourages the mindset of empowerment to do good for self and others.

The proposed organic farming business model being created here blends together aspects of the Smiling Gecko and the smart forest farm business models to become a model for creating increased growth and physical wellbeing within rural areas. It additionally helps increase farming incomes and spread risks through its multiple crops approach, and develops a proactive social model for farming community. The proposed business model also aids carbon capture, helps address climate change risks, increases biodiversity and opens up further opportunities for agritourism.

After obtaining and analysing the survey results, and comparing these with the findings made in the literature review, the business plan for the SATI model was further developed and refined as shown in Table 3.6.

Table 3.6 Research steps used to create the SATI model (research tools)

<table>
<tr><th colspan="5">Data procedures</th></tr>
<tr>
<td rowspan="3">Data Collection Methods: Literature Review in order to understand the background and the process of each techniques.</td>
<td rowspan="3">Investigate the existing barriers</td>
<td>Step 1: Questionnaires
: In-depth Interview</td>
<td rowspan="3">Qualitative Content Analysis</td>
<td rowspan="3">Step 4:
Creating a sustainable Guideline model initiative “SATI Model” and financially successful for Smarter Organic Communities.</td>
</tr>
<tr>
<td>Step 2: Activities and sightseeing: indicates possible benefits and obtains feedback.</td>
</tr>
<tr>
<td>Step 3: Online survey</td>
</tr>
</table>

CHAPTER 4
RESULTS AND DISCUSSIONS

This chapter presents the main findings from the in-depth interviews that were undertaken and the findings that were obtained from the online questionnaire that ran from 17th June 2020 to 28th July 2020. Further details of these, including the full transcripts from the interviews, are contained in the appendices to this thesis.

4.1 Section 1: In-depth interviews

This section presents results from some of the primary research collected through in-depth interview. The study area selected was chosen to focus on places where economic crops are planted, as well as business practices undertaken, in order to plan for long-term community development.

4.1.1 Perceptions on organic farming

Interviewee No.1 states that "organic farming can be done, but it is difficult". This is one of the reasons why it is of great importance to create a knowledge sharing data base that is easy for people of all ages and technical abilities to gain access to so they can learn from experts as to what is achievable. This is also one of the reasons why it is necessary for individuals to become aware of the wide range of benefits that can be achieved from particular actions, and how smarter ways to achieve them should also be known about. In this thesis, it is proposed that "smarter ways" are better ways to do things that can involve the adoption of either high-tech or low-tech approaches or a blending of such methods to sustainably and cost-effectively achieve better bio-friendly outcomes that bring added value and quality to life. When asked what skills and training he considered smarter organic farmers, such as those involved in smart agroforestry needed most in order to be successful, he stated that: "Farmers should learn to be self-reliant, ready to experiment and learn as much as possible."

It is interesting to note that Interviewee No.3 considers that with regards to the perceived level of difficulty in undertaking specific types of farming, such as organic or chemical farming, the answer "Depends on the farmer's perceptions. We cannot change their mind to agree with us." He estates that they are shown the sustainable methods of farming by King Rama IX. He considers it is up to the farmers themselves whether they choose to adopt such methods.

He additionally thinks of what is needed to make farmers more open-minded and help bring them onboard to become leader farmers.

4.1.2 Perceptions on the use of technology

When asked for his perception on farmers who are unwilling to use new technology, Interviewee No.3 stated that: "Those farmers have different perspectives, some of the older farmers are willing to learn and apply modern technology, some of them are not. Most of the new generation understand the theory but are unable to put the theory into practice, such as observing diseases and knowing the amount of chemical that can be used in farming. If they do not get experience through learning from older farmers, they will probably not be a success in farming." These are very interesting observations, and go beyond typical opinions that people give. They are very much in line with the thinking of the SATI model which emphasizes that the smartest advancements can be made when different mindsets are brought together. As has been observed by others, "You need two wings to fly."

The benefits that the appropriate use of technologies can bring is also mentioned by Interviewee No.4, who notes that with regard to coffee production, the introduction of the correct machinery can result in higher quality produce. The key seems to be acquiring balance and finding out what works best in each individual situation.

4.1.3 Learning Centres for Thai farmers

The Thai farmers learning center in Suphan Buri that most of the interviewees are from has become a popular agritourism attraction and provides a wide variety of activities for general visitors, in addition to being a learning centre for Thai farmers and a place where they can purchase a wide variety of seed types. Interviewee No.2 notes: "We welcome various people who come for observational study, such as

school pupils, college students, those in the private sector, the government sector, the Subdistrict Administrative Organization (SAO), and foreign government agencies to review issues about rice farming, technology in seedling production, rice varieties and farming concepts."

They also educate visitors on the late King's achievements and activities with regards to Thai farming. In the future its owner intends to build a hotel that will provide banqueting services and wedding arrangements to complement its existing "restaurant, café, gift shop, and areas for exercise".

Interviewee No.3, the owner of that Thai farmers learning centre also intends to build a school there for the benefit of the younger generation. It is interesting to note that a number of its objectives are also contained within the Smiling Gecko model and the proposed SATI model.

4.1.4 Thinking from different viewpoints

It is important to try to observe things from a wide variety of viewpoints in order to obtain a fuller perspective as to what can be achieved and to try to determine how people can work more harmoniously with each other to achieve better end results. For this reason, the viewpoints of two of the interviewees who took part in the in-depth interviews are compared and contrasted (Table 4.1).

Table 4.1 Comparison of feedback obtained from a farm expert and a coffee business expert directly involved with coffee farmers

	Interviewee No. 3 (Owner of a Thai Farmers Learning Center).	**Interviewee No. 4** (Head Barista at specialty coffee firm).
Status	Owner of a Thai farmers learning centre.	Head barista of coffee shop.
Age	50 years old.	30 years old.
Place	Thai farmers learning centre in Saraburi, Thailand.	Specialty café (works in collaboration with a coffee farmer in Chiang Rai, Thailand).
Objective	The centre aims to be the source of the best quality seed stock in Thailand and welcomes people of all ages to visit it.	To learn the art and craft of good coffee farming as much as possible and share these insights with the customer.
Welcomes	Study visits from groups of students, government agencies, and visitors from foreign countries.	- Farmers, Tourists, Coffee roasters, Baristas.

Table 4.1 Comparison of feedback obtained from a farm expert and a coffee business expert directly involved with coffee farmers (Continue)

	Interviewee No. 3 (Owner of a Thai Farmers Learning Center).	**Interviewee No. 4** (Head Barista at specialty coffee firm).
Existing approaches / Main challenges and opportunities	- Weed and pest control related to rice crops, drought issues, and low prices for rice produce sold. - Concerned that if pesticides are not used insects will harm the crops. - Old farmer generation mindset and debt.	- Concern over use of chemicals. - Differences of thought. - Cultural differences.
Key success	Indirect seeding.	Learning and testing.
Future plans	Hotel and self-learning centers and tend to build schools.	Increased connection between the organisation and the coffee farmers.
Their solutions	Germination to harvest.	- Field trips to the coffee farms. - Teaching skills and methods to others.

The in-depth interviews revealed that both interviewees faced risks from external factors, such as unfavourable weather conditions for planting. Interviewee No. 4 said that weather impacts retail shops substantially and also affect consumer behaviour and purchase decisions, with many preferring to place orders online instead. Interviewee No. 3 additionally mentioned the challenges of being faced with the problems of weeds, drought and the increase of rice prices due to product shortages and increased demand due to the COVID-19 pandemic.

Both interviewees recognised that they have to adapt, diversify and create new opportunities for themselves to do new things during periods of low earnings to be able to support their families. Not every member of the old-farmer generation is open-minded and prefer the complexity, however, and some may wish to continue as they are rather than trying to plan ahead or use new technology. This can be because they have previously survived through growing monoculture crops and they are averse to change. Interviewee No. 3 viewed it as a matter of urgency that we should bring people together to learn how they can become leader farmers. With regards to agroforestry practice, Interviewee No. 3 mentioned that the combination of a variety of plants will create a self-regulating ecosystem that does not require chemicals but that such situations may not be suitable for people who do business

agriculture or monocultural farming. Hence, the integrated farming approach that is effective does not plant crops continually in the same part of the garden, and rotates crops leaving areas fallow for a while, so the soil will get more nutrients and be able to recuperate better so insects are less likely to come again. Shifting cultivation will provide increased benefits and better quality of plants, as well as precision predictions that are of use to both high-tech and low-tech approaches.

Interestingly, Interviewee No. 4 mentioned that most of the farmers they collaborate with are often either older generation farmers who have new perspectives or new generation farmers who have new perspectives. He mentioned that coffee makers and coffee farmers can have some conflicts with each other because each can hold different perspectives and goals. Hence, the way to let them share, learn and be ready to adapt some of their knowledge together could be the best way forward.

4.1.5 Example of thinking smarter: How SATI might address the issues raised on the rice farming

As an example of what can be achieved through openly gathering and sharing knowledge and seeking to create 'Win/Win' situations, mention is made of the problem Interviewee No. 4 raised with regards to the risk of insect damage to rice crops. In the fully developed SATI model, a variety of options would be provided in easy to understand formats to help address such issues, with particular emphasis being placed on solutions that can create multiple benefits both to farmers and those who purchase their products. One long proven low-cost low-tech smarter organic solution that helps address the problems raised is the introduction of ducks into rice fields to eat weed seeds, insect pests, slugs and snails. The manure created by the ducks is also highly beneficial to soils and plants resulting in higher crop yields and reduced costs. The ducks themselves can additionally be a source of meat and eggs if required (Mburia, 2016). All this can be achieved without expensive chemicals and benefit the farmers and end users.

Additionally, as previously mentioned, with the SATI model, both traditional and newer solutions can be combined. A more recent breakthrough that might also be adopted is the adoption of aerobic rice production instead of standard

water-intensive rice production to help address the issues of water shortages and climate change. Growing multiple crops can also reduce risk (Theparat, 2019), and there are even opportunities to undertake such measures with regards to rice when practicing agroforestry. Furthermore, the FAO (2017) notes that incorporating trees into areas where rice production is undertaken helps improve water retention of the soil, reduce local temperatures, diversifies agricultural production and stores a greater level of carbon than standard monoculture approaches. With the SATI model, many problems can be assessed to see if there are smarter organic farming approaches available that can help increase resilience and reduce risk. Developed correctly, its database would continue to grow and be refined to better reflect what is achievable and enable all stakeholders to become part of the solution.

4.2 Section 2: Online questionnaire

In Section 2, the data were obtained online from participants who responded to the online survey specially created for this work. The aim of this questionnaire was to understand more about individuals' personal knowledge and perceptions on agriculture. The respondents were either: individuals interested in agriculture or involved with agricultural matters; people who live in an agricultural community; or people who are interested in agricultural tourism, agricultural activities and/or are nature lovers.

The online questionnaire contains four sub-sections: general information; agricultural matters; specific questions for those interested or planning to do agriculture; and specific questions for those interested in creating their own imaginative community hub.

4.2.1 Part 1: General information

There was a total of 55 respondents to the online survey. Of these, 36% (n=20) were male and 64% (n=35) were female. Details of their age ranges and the locations they live in and those on the respondents' level of education, career and salary are respectively provided in Table A1 and A2 in the Appendices. As expected, considering demographic data, it may be assumed that those who participated in the online survey may not be typical farmers with low-income in Thailand as shown in Figure 4.1.

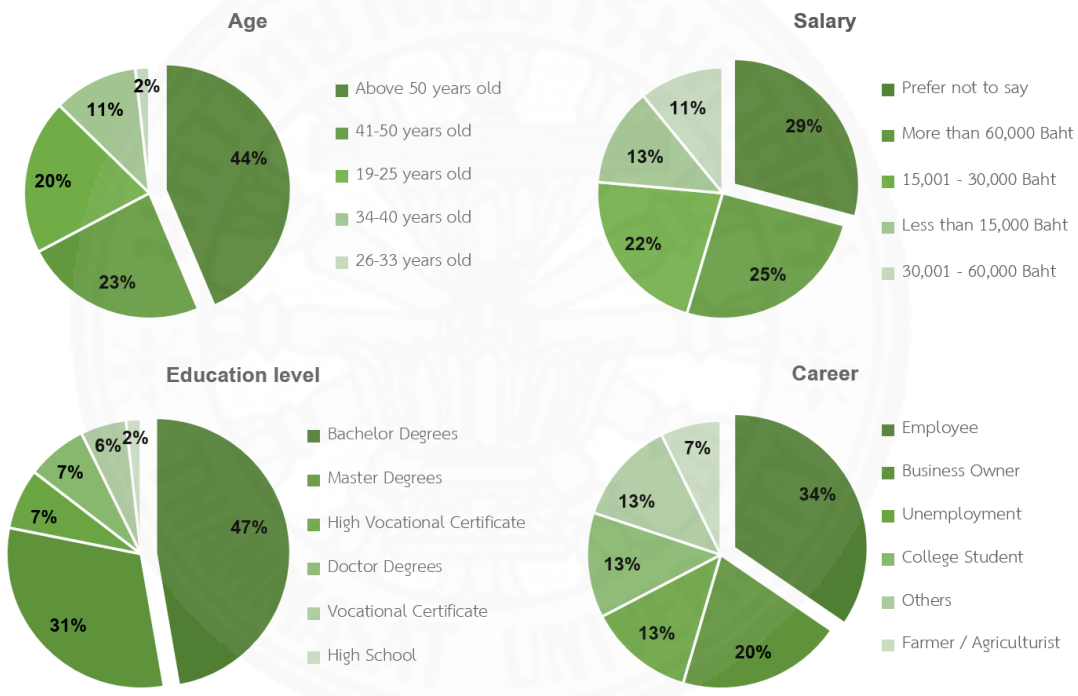


Figure 4.1 Demographic data of respondents

As shown in Figure 4.1, those listed as 'Others career' are as follows: 1.8%, 1 housewife; 1.8%, 1 Self-employed brand consultant; 3.6%, 2 retired employees; 1.8%, 1 government organisation employee; 1.8%, 1 designer; and 1.8%, 1 doctor.

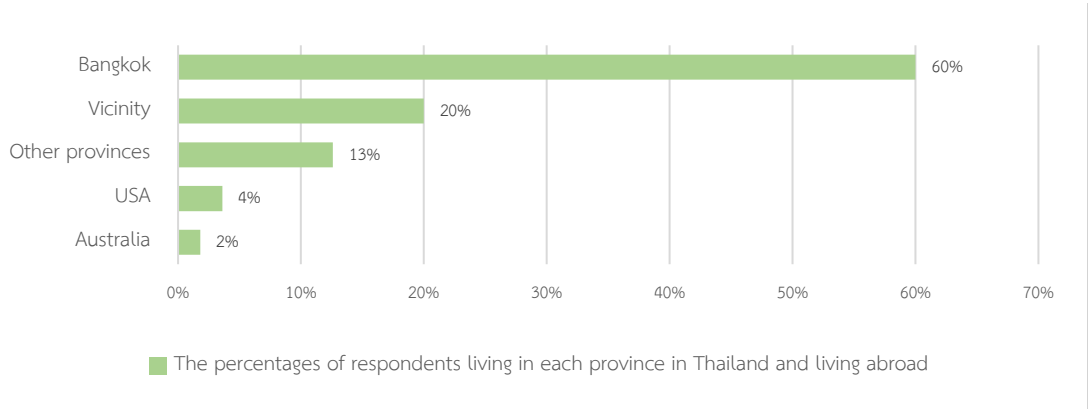


Figure 4.2 Current area where respondents live

As show in Figure 4.2, The percentages of respondents living within Thailand outside of Bangkok listed as Other are as follows: 7% from Rayong Province; 1.8% from Sakon Nakhon Province; 1.8% from Chon Buri Province: 1.8% from LabLae District, Uttaradit Province; 1.8% from Phichit Province; 1.8% from Suphan Buri Province; 1.8% from Nakhon Nayok Province; and 1.8% from Chiang Rai Province.

Data provided by the Ministry of Agriculture and Cooperatives, cited by Rigg et al. (2019), revealed that in 2012 most farmers in Thailand were about 51 years old. Most of the participants in this present online questionnaire are >50 years old (44%). Over 51% earned above the latest 10-year average monthly household expenditure in Thailand of 21,157 Baht (National Statistical Office of Thailand, (n.d.)). Most of the respondents are from Bangkok and its vicinity (80%), well educated (85% with bachelor degree onwards). In contrast, only 7% consider themselves farmers or agriculturists.

4.2.2 Part 2: About agricultural matters, to understand respondents' behaviours related to agriculture

There was a total of 55 respondents to the online survey. This section of the questionnaire was created in order to better understand respondents' behaviour related to agricultural matters. Respondents' responses to this, for which they were allowed to provide more than one answer, are shown below in Figure 4.3.

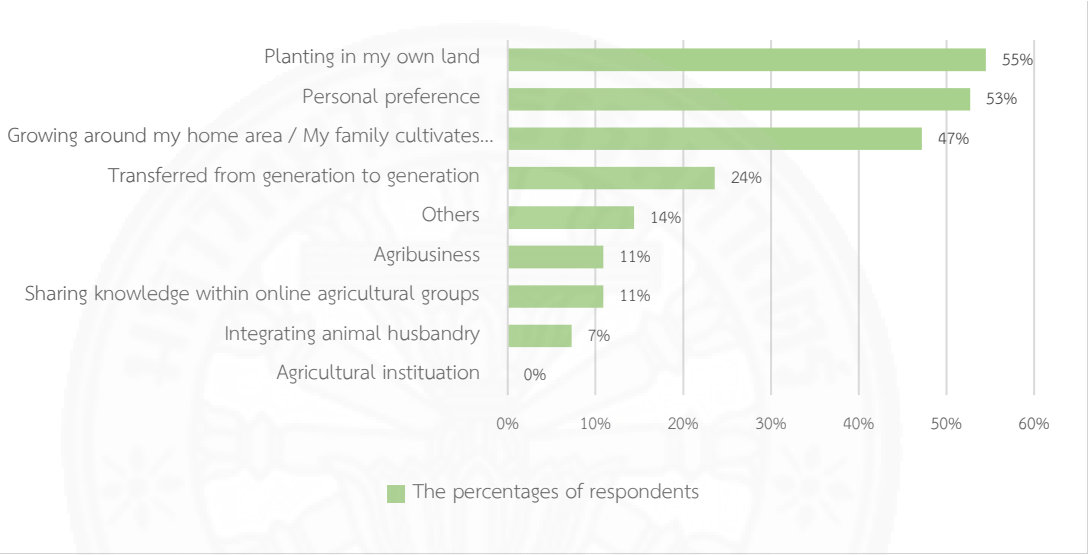


Figure 4.3 The main reasons for participants to be involved in agriculture

There are 55% who prefer planting in their land, followed by 53% are personal preferences, 47% are growing crops in their home area, or member of families cultivates, 24% is transferred between generations, 11% are plan to do agri-business as well as sharing knowledge within online agricultural groups, and 7% are want to do integrate animal husbandry.

In this question, "Others" (14% of the respondents) said they: see the importance of sustainable agriculture; want to learn about the agriculture sufficiency model; learn from Asoke community online and through YouTube; learn to be self-reliant and sharing; do organic farming in which the friends are the caretakers; and escape from the city. Only one of them is just a consumer.

Respondents' responses to this, for which they were again allowed to provide more than one answer, are shown below in Figure 4.4.

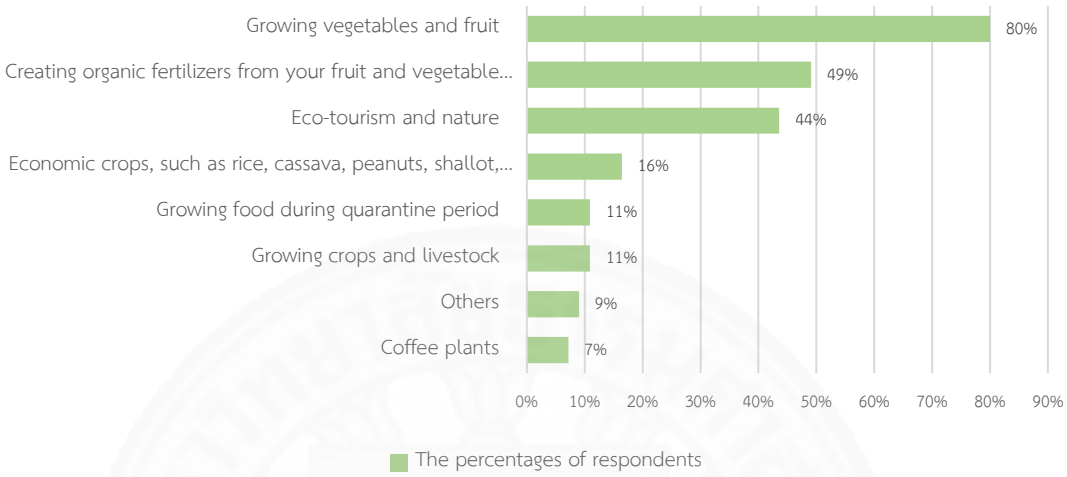


Figure 4.4 Type(s) of agriculture that participants are interested in

80% of respondents were interested in growing vegetables and fruit and 49% interested in creating organic fertilizers from leftovers. Besides, some respondents prefer eco-tourism and nature (44%), followed by economic crops (16%), Growing food during quarantine (11%), Growing crops and livestock (11%), and coffee plants (7%).

In this question, "Others" who were 9% of those who replied (or 5 respondents) said they are interested in integrating farming, forestry and long-life vegetable surface plants, willing to open a center if done well, a forest park, and provide a farming stay.

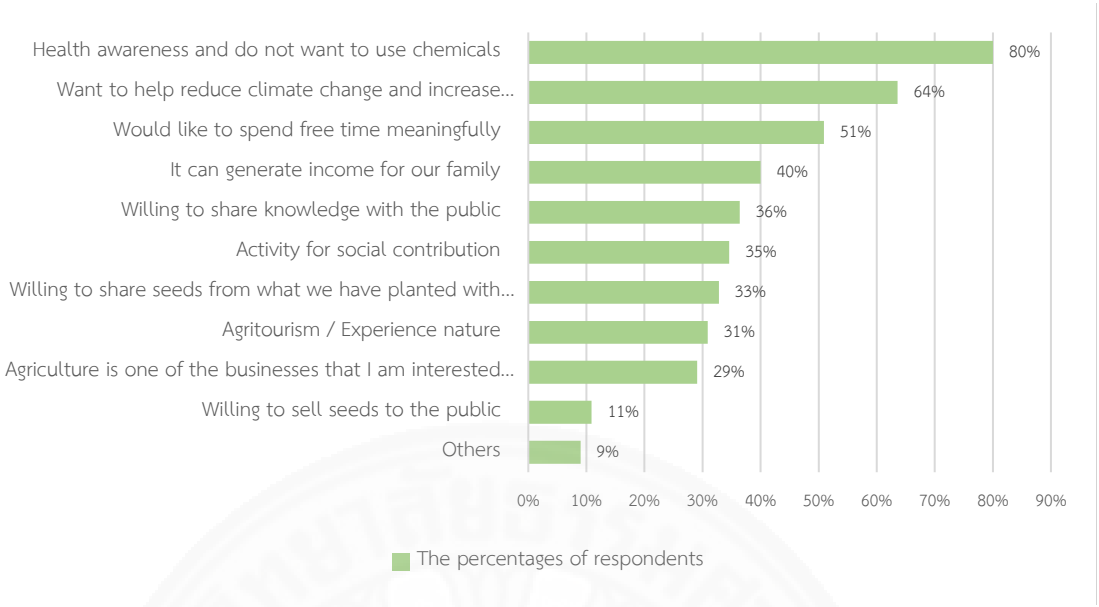


Figure 4.5 The reasons why participants like agriculture

80% of respondents are aware of health. In comparison, 64% want to help reduce climate change and increase sustainability, followed by spending free time meaningfully (51%), concern on income for family (40%), sharing knowledge with the public (36%), activity for social contribution (35%), shared seeds from what they planted to others (33%), Agri-tourism (31%), Business interest (29%), and 11% are willing to sell seeds to the public.

Others, (9% of 55 respondents) said because: it gives health awareness; increases food resilience; organic agriculture is a way of life; and creates a forest heritage for the next generation.

4.2.3 Part 3: Specific questions for those interested or planning to do agriculture

Those who are not interested in doing agriculture were told they could go to the last part of the survey.

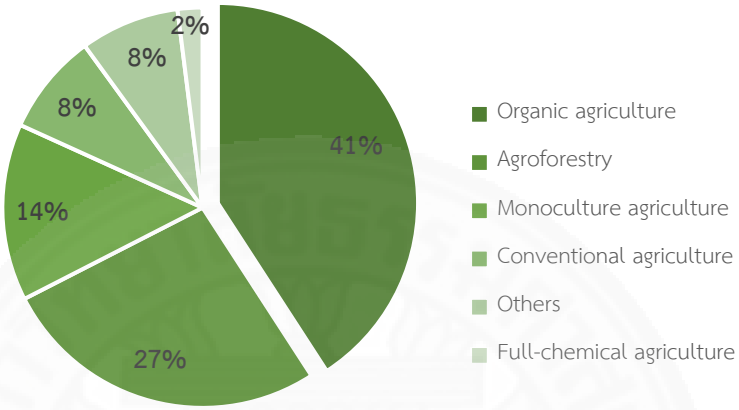


Figure 4.6 Investigation of the different kinds of agriculture that participants currently do

Most of the respondents (41%) said they grew organic agriculture, fewer than 30% grew agroforestry and monoculture agriculture, and less than 10% grew conventional agriculture. Only 2% did chemical agriculture.

Others (8% of the 49 respondents), said planting ornamental trees in the house area, releasing naturally, planting for eating and not planting.

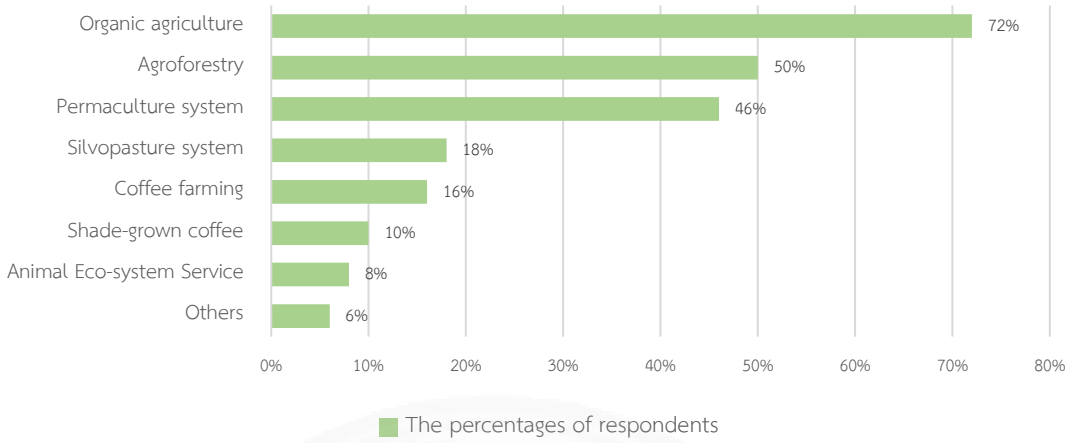


Figure 4.7 Investigation of other kinds of farming methods and techniques they know

More than 50% of respondents knew organic agriculture and agroforestry. In comparison, 46% knew permaculture technique while least than 20% knew the silvopasture system, coffee farming, shade-grown coffee, and animal eco-system service.

Others (6% of 50 respondents), said they know: the Khok Nong Na model; studying of Dharma with agricultural methods; and one of the respondents did not know about agriculture methods.

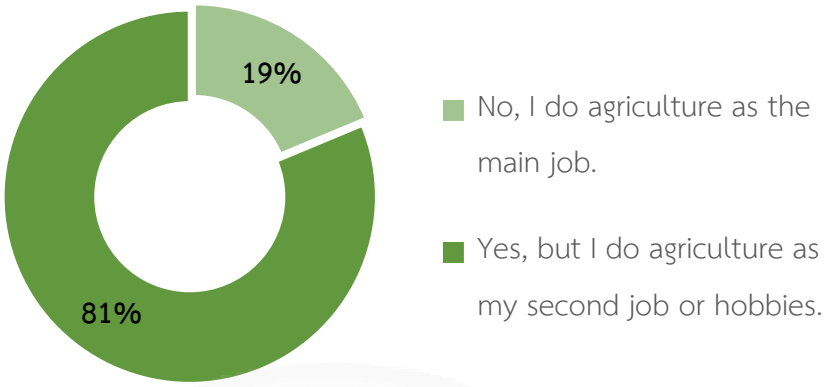


Figure 4.8 Percentage of participants who have other careers while undertaking agriculture

From the survey, there were 48 respondents who answered this question and only 9 respondents who do agriculture as a main job, consist of one farmer from Bangkok who are interested in organic farming in order to reduce the use of chemicals, and applied the technology use in the farming. And another person from Suphan Buri Province who do interested in agroforestry farming and uses both wireless technology and machines for farming. He also mentioned that smart farmer can happen in the next 5 years. Other 7 respondents including employee (3), unemployment (2), and retired employee (2) and all of them just planted in home area, one of which was involved in participated in reforestation and joined the agriculture matters.

In addition, there are 39 respondents who do agriculture as a second job or hobby, which 1 of them is a farmer living in the vicinity of Thailand and pointed out that agriculture may be expanding and be an alternative way of living for many people who are interested in this activity after the COVID-19 subsides. There are 9 respondents who gave no comment.

In this section analysis was undertaken of the barriers, obstacles, and challenges the respondents have experienced, followed by investigation of the other kinds of agriculture that they wish to undertake instead of chemical farming.

4.2.3.1 The barriers, obstacles, and challenges that participants face

Some of respondents mentioned that they want to understand more about the habits of each of the plant types they are interested in, the problems that can arise from unfavourable ecosystems such as insects, worms, birds, weeds, pests and other factors that interfere with plant growth and how these can be addressed.

Some have been faced with the problem of agriculture crops that do not grow as they expected, whether through plant death, unhealthy plants, some face external factors such as drought, lack of irrigation water and water with low PH, as well as unfavourable climate conditions that can affect the quality of produce and soil (Soil acidity or lack of nutrients in the soil, sandy soils that are loose and light, slope areas, pond for water storage that have collapsed during the rainy season).

Also, some have said they still lack enough farming knowledge and know-how on natural fertilizers, lack of skills training in agriculture or different of agricultural concepts, professional labour shortages, tractor training, some said that the government system in Thailand that does not provide enough support, high shipping costs because the rice must be sent to Bangkok in order to make it cost effective, and the fact that some of local people still not give a proper value for organic rice.

3 of respondents mentioned wanted to know how to lower costs of production and improve financial returns, know which plants are the best ones to get and how to look after them properly, while one of them wants to working with a farmers' community in order to understand matters better, and wanted to learn discipline in creating new products that are sustainable and good for the environment.

4.2.3.2 Reasons for changing from chemicals to other methods

3 respondents mentioned that they used to use chemicals during farming and gardening because they are easy to find and convenient to use, and of the 5 respondents who still use chemicals, one of them is trying to use as little as possible. Also, 7 respondents said they had changed to do other kinds of agriculture because conventional agriculture is unhealthy, while one of them has been adverse

experiences with chemicals. It was additionally commented that there were negative affects to the environment including causing the soil to lose nutrients.

At the moment, 4 respondents are non-chemical users, with one of those making compost from fruit and vegetable scraps, use fertilizing or making their own fertilizer, and make their own organic fertilizer. Also, there are 16 respondents who never use chemicals at all because they aware of the chemical impact to the environment, including impacts to their health and the health of others.

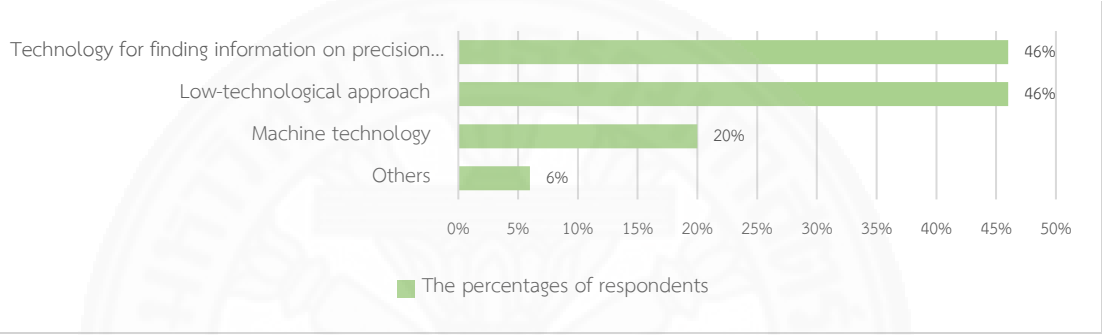


Figure 4.9 Kinds of technology that participants use to help in farming activities

46% of respondents use technology for finding information on precision farming and also others 46% of respondents are low-tech approach. Only 20% used machine technology in farming activities.

Others (6%, 3 of the 50 respondents), said: use technology to assist in farm management and launch into the market; soil preparation machinery; labour force; solar cell electricity; and automatic water systems.

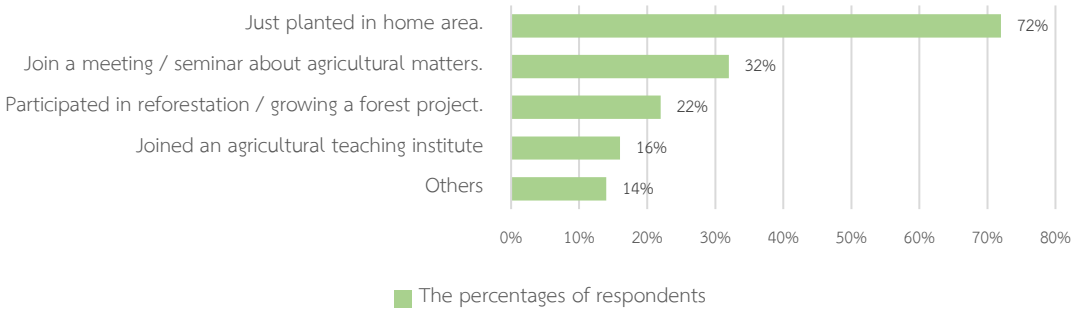


Figure 4.10 The participation of respondents in training and related support

Others (14% of 50 respondents), said: they went to see the planting site; they work with the agricultural community; help farmer with proper knowledge; and self-learning from the Internet. 2 said none of the above.

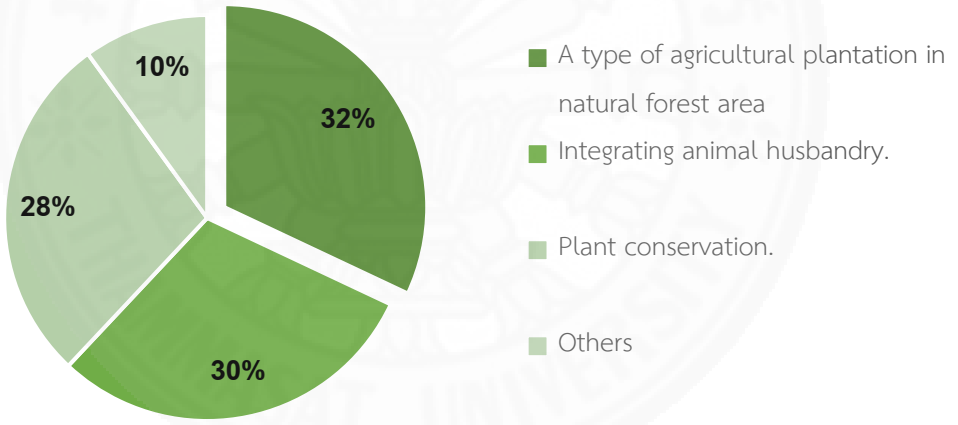


Figure 4.11 Respondents' perceived meanings of integrated farming or agroforestry

The question was set in order to know how respondents understand the meaning of agroforestry. More than 25% said it is a type of agricultural plantation in natural forest area, integrating animal husbandry, and plant conservation.

4.2.4 Part 4: The Question if respondents are involved in / become involved in creating a smarter organic farming community in order to know some of their considerations

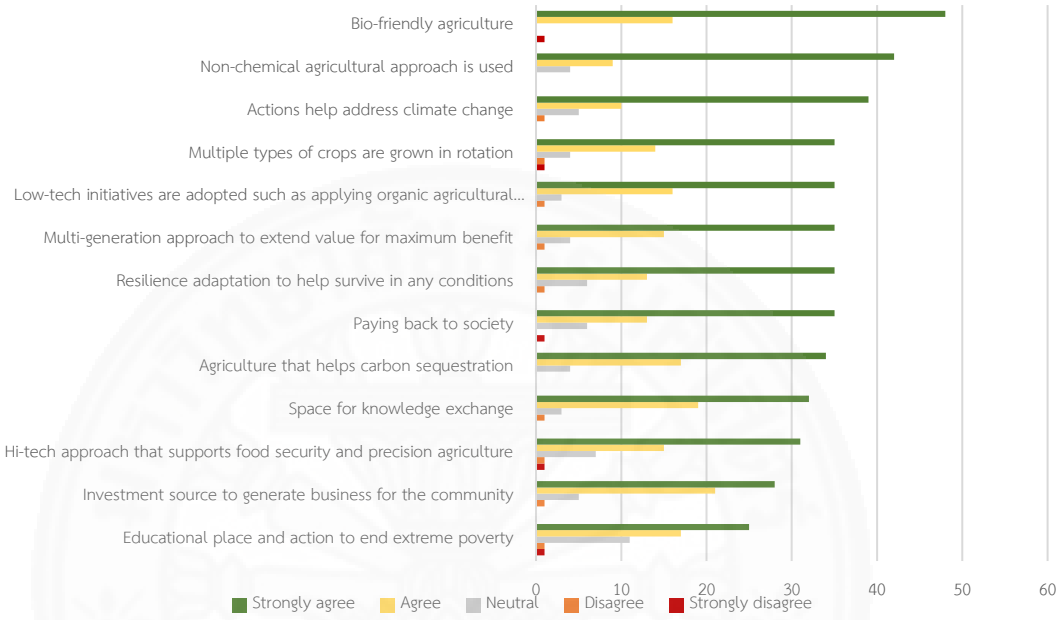


Figure 4.12 Responses to the question "If you are involved in / become involved in creating a smarter organic farming community, what are some of your considerations?"

From the results to measuring awareness of what is needed in order to creating a guideline as a Smarter Organic Farming Community (Figure 4.12). For strongly agreed, 48 of respondents are taken into the most consideration for development of bio-friendly agriculture, followed by 42 of respondents consider to address climate change, Non-chemical agriculture approach is used, while the multiple crops, low-tech initiatives approach, multi-generation, resilience adaptation and payback to society were got 35 of respondents.

And 21 of respondent agreed on having investment source to generate business for the community, followed by 19 respondents agreed on having space for knowledge exchange, and 17 of respondents agreed on having educational place that take action on poverty reduction as well as agriculture practice provides that carbon capture.

Everyone should be allowed to earn a fair wage and have proper working and living conditions in order to increase the quality of their lives and health. Creating a greater sense of value within rural communities is important because farmers are of high importance to food security.

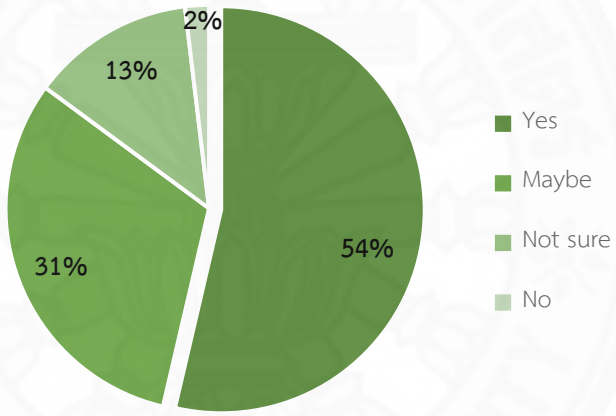


Figure 4.13 The percentage of agreement that smarter agriculture community hubs could increase the potential of farmers, increase their incomes, and help develop rural communities

In the last sub-section, respondents were asked their opinions on what the direction of agriculture or agribusiness should be in the next five years, followed by what additional skills they want to learn to increase their potential, and their other suggestion. In the discussion below, the results from those questions have been split into what has been said by people within different age groups.

4.2.4.3 Participant's opinion of what should be in the direction of agriculture or agribusinesses in the next five years

Those aged 19-25 years mentioned that farmers have been a major driver of the Thai economy for generations and have contributed much. But if there is little effort made to help them progress, Thai farmers might not move forward or may get worse. They believe that there must be some source that can provide both knowledge and enable farmers to develop their potential so that they can have stable incomes and become more capable. Such initiatives can lead to increases in agricultural production and goods. However, this depends on how much the potential entrepreneur will accept the advancement of technology, look for answers and have readiness in every situation. "Changing the traditional way may require capital to add modern technology, equipment and tools to become a smart farm for sustainable agriculture" one of respondents said.

As a result of the COVID-19 pandemic and the trend for increased demand in plant-based foods, people are becoming more aware on how diet can contribute to a healthy lifestyle. Farmers should have good access to knowledge and technology that helps them undertake agriculture more effectively, and the government could help support them more on these issues.

Those aged 34-40 years mentioned that people are starting to become more aware and concerned about food security and the benefits of organic farming compared to conventional farming that uses chemicals. On the other hand, if agricultural land decreases for farmers, there will be less productivity. So, the demand always affects market prices. One of them mentioned that measures should be taken to help address inflation problem in order to help improve the quality of life and security in life of the farmers.

While those aged of 41-50 years said that they want to reduce the use of chemicals to make farming more environmentally friendly and to encourage farmers to be more self-reliant. One of them said that we should use organic agriculture techniques instead of monoculture agriculture techniques in order to reduce the use of toxic chemicals. Importance was also placed on people learning to work in harmony with the environment following the sufficiency economy model. It

was suggested that the government could help with this process. Our country already has an advantage over others and can access the technology, marketing and management in order to increase the potential of Thai agricultural products. (It is proposed that with the SATI model it could progress such initiatives even further).

The group of respondents aged 50 years and above said that all chemicals should be eliminated, organic farming practices should be undertaken and that attempts should be made to connect with community members and focus on their well-being, reduce the dependence on industrial products in both agriculture and daily life (as we see the agricultural industry developing but the environment still being destroyed).

4.2.4.4 The additional skills that participants would like to learn to increase their potential in addition of agriculture

Most of the respondents said that they want to learn about the processing and marketing which can help them to increase their income, and how technology be used effectively and adopted into their farm activities.

Those in the age range of 19-25 years responded that they are interested to learn more about plant species, how to arrange the vegetation in their homes, room decoration with healthy plants, non-food and animal husbandry, and marketing.

There is only one respondent in the age range 26-33 years, who said that they wanted to create a co-studying space that would help them increase their potential.

Those aged 34-40 years are interested in agricultural products and processing, and ways to increase fresh air and create peace. They are also interested in the technology that could be used effectively in agriculture (one of farmer mentioned this), solar energy system design and other forms of alternative energy.

Respondents in 41-50 years age group are interested in transformation and processing, marketing and online marketing, with one of them wanting to expand the way to sell the products, agricultural technology, ecosystem creations, adding more easily accessible knowledge into agriculture than ever before, writing a story that invites people to join, making organic fertilizer and waste recycling

for making fertilizer. Also, some of the Thai farmers mentioned that they want to know about career groups, astronomy, seasonal farming and Thai traditional massage.

Those in the age group 50 years and above were interest in learning about agriculture through television and online media, self-development from both physical and mental health from nature, psychology, accounting, finance, marketing and online marketing, distribution channel and products. Over 5 respondents, including an existing Thai farmer, were interested in product processing or agricultural products, food science and nutrition, and modern agricultural technology such as solar cell power or computers for agriculture. One of them mentioned that farmers should join together to strengthen their negotiation power related to the raw materials they need, and rough out an appropriate price. And one of them is interested in planting crops that have the ability to be carbon used for carbon sequestration.

4.2.4.5 Other suggestions

The respondents mentioned that there should be a research agriculture institution that can be used for production, and can increase productivity for current farmers, and for those who are beginning to enable them to understand agriculture better while providing income for their households. Some of them said that the wants and needs of each person on each matter can be different as related to issues such as poverty reduction/elimination, intelligent agriculture, etc. that may cause misunderstandings and that this will need to be worked on. We should create the knowledge about how better, more sustainable development can be undertaken that can create benefits for all.

The results of the above survey indicate factors that affect individuals who are either doing, or are interested in undertaking farming activities in their area, whether at large-scale or at the small-scale activities of an individual. They also indicate the obstacles and challenges they have or may come up against. The SATI model was initiated with the intent of helping them tackle these problems by starting with creating a guideline for efficient and sustainable farm production.

The literature review also demonstrates the prevalent use of agrochemicals, and the effects they can have on farmer life including: various

environmental problems, economic difficulties, crop fluctuation and health concerns. It also reveals the growing organic market and the benefits of undertaking smarter organic farming and agroforestry practices, including the ability to improve through active carbon sequestration, helping address poverty and income issues, along with food security, permaculture issues and draft animal selection.

The open cluster model concept allows sustainable community growth and enrichment. It can be the representative of a sustainable community-based mindset to thrive and bio-friendly agriculture that is resultant in the generation of innovative biologically-friendly smart villages and lifestyles. The development of such a community can be achieved. It requires the application of good knowledge and practical management skills, the ability to think differently, change perspectives when required, and realise the value and potential in others whatever their age.

The differing approaches to technology also need to be addressed to maximise beneficial exchanges between old-generation and new generation, and enable the design of intergenerational inclusive community learning centres.

In addition, obstacles and challenges which can explained in part as unfavorable ecosystems, lack of skill straining and financial learning need to be addressed. The supporting factors that can enable the successful refinement of the SATI model were mentioned by the majority of participants in both in-depth interviews and the online survey which include that self-development is necessary in order to develop SATI communities.

As Auamnuaychai, (2019) mentioned that not using chemicals can reduce production and profit which in turn can negatively affect farmers' income during the transition to organic farming. Smarter farming methods are available to help address and progress such potential shortfalls. One such method is growing crops under vertical electric fields during the transition period. This is already being commercially undertaken in China, and elsewhere, where it has been shown that applying vertical electric fields above crops can boost output by 20-30% while reducing the need for pesticides by up to 100% (Chen, 2018).

Incidentally, all participants mentioned that they are aware that chemical use negatively affects their health and safety, and they are all concerned about this issue and want to solve it. However, it can be seen that incentives for providing guidance on this issue are required, as are high quality networking and support to create smarter biologically-friendly agriculture initiatives as part of the smarter cluster development initiative.

No matter how large or small the size of farming activities, it is intended that the SATI guideline can provide guidance on smarter best practice measures that can be undertaken. For example, to achieve in well community-based, it should be achieved in the stage of education by providing education for young generation; improving skills of each people as well as providing hi-tech and low-tech approaches by local specialists and others that also help address ageism and differences in people's technical abilities; and help provide fair income distribution and reduced inequalities. Such measures provide a vital next step in improving the bio-friendliness of agriculture while providing a better environment and decent work and economic growth.

However, a summary of all participants during the COVID-19 pandemic affected severe life adaptation, Table 4.2 describes the willingness technique and what could be provided for them. This can be a key conclusion for people which it is recommended should be investigated further in future research.

Table 4.2 Techniques for enhancing the "Triple Bottom Line" of sustainability

	People : Smart farmer	Planet : Ecosystem	Profit : Paying back to society
Circular-Learning that can be provide	• Plant species. • Tree or gardening decoration. • Food science / nutrition. • Agriculture knowledge such as fertilizer knowledge. • Recycle / Circular waste. • Sense of community. • Adaptation technique or learning to adapt to every situation. • Consumer behavior.	• Recycle or making kitchen composting. • Raising animal service. • Creating ecosystems. • Crops with ability of carbon capture. • Agroforestry. • Integrate farming. • Plant-base trend.	• offline and online marketing • Finance and accounts. • Public relation, Distribution channels. • Computers, tools, machines or modern agricultural technology. • Processing of agricultural products.
Additional suggestions / If create this guideline, what can be done?	• Educating future generations which will be led to further or be a professional. • Working with farmer's communities can creating new understanding and discipline in create a product that concern the environment and resilient. • Adaptation technique must consider to consumer safety. • Co-study space that able to give knowledge and implement accordingly.	• Forest plantations may be a source of psychological healing. • Sustainable agriculture. • Farmers are knowledgeable and can access to the technology in farming. • Increase the value and increase the green area.	• Farmers should become as a group in order to increase the ability on bargain power, the raw material needed and set the sales price. • Require funding for add the technology and for community support as if grows. • Energy that self-reliant (Solar Cell Energy). • Cooperation by a team of academics and Specialist.

With the SATI model, the mindset of empowerment is not of people “doing less harm”, it is of people “doing greater good” and helping themselves while helping others and the planet.

This thesis has investigated a number of the existing and future risks are faced by Thai farmers and members of rural communities. It has also investigated how they can be addressed. The Smarter Agriculture Thai Initiative (SATI) sustainable organic farming model helps provide a new future for rural communities where growth and better-quality living can be achieved by all.

The findings from the in-depth research undertaken for the critical literature review, in conjunction with the responses from both the in-depth interviews and the online survey undertaken for this work, provide many insights and much useful knowledge that can be applied to creating a better future for Thai farmers and rural communities.

The proposed SATI Guideline model seeks to address these needs through blending together appropriate aspects of different business models in conjunction with inclusive multi-generational stakeholder involvement to provide a sense of ownership from those involved.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

This thesis has investigated a number of the existing and future risks that are faced by Thai farmers and members of rural communities. It has also investigated how they can be addressed. The Smarter Agriculture Thai Initiative (SATI) sustainable organic farming model helps provide the opportunity for a new future for rural communities where growth and better-quality living can be achieved by all.

The findings from the in-depth research undertaken for the critical literature review, taken in conjunction with the responses from the online survey undertaken for this work, provide many insights and much useful knowledge that can be applied to creating a better future for Thai farmers and rural communities.

5.1 Key findings

The SATI Guidelines that have been developed have the three pillars of sustainability at their very heart: PEOPLE (Smarter Farmers, Smarter Communities); PLANET (Ecosystem); PROFIT (Decent work, Economic growth and Paying back to society) as shown in Table 5.1.

Table 5.1 SATI guidelines and lists of what can be achieve and covered under the three pillars of sustainability

	People: Smarter farmers, smarter communities	**Planet: Ecosystem enhancement**	**Profit: Decent work, Economic growth and Paying back to society**
What can it achieve?	• Health promotion. • Good education for all. • Healthy, reduced risk, environmentally-friendly farming. • Good quality lives. • Growing worthwhile and caring communities. • Thinking differently, blending the old and the new. • Reversing rural decay.	• Improving ecosystems, the services they can provide, and bio-diversity. • Carbon capture. • Building in resilience to climate change. (Addressing fire, flood, drought, pests, water and soil quality risks). • Creating smarter solutions that blend hard- earned knowledge and wisdom with modern day developments.	• Improving the lives of those around you. • Caring for others and empowering them. • Helping each other to help ourselves. • Helping other to help themselves. • Adding extra value. • Making lives worthwhile.

The SATI guideline stages offer the opportunity to create multiple benefits, to blend the best of traditional and new solutions, to bring communities and generations together, to increase knowledge dissemination, to improve food security, general health and wellbeing, and to regenerate rural communities for the first pillar, PEOPLE.

It works in close harmony with nature, using smarter best practice know-how and wisdom to encourage bio-diversity, crop diversity and resilience. Furthermore, it enables improved carbon sequestration within the agriculture sector and helps reduce environmental risks, for the second pillar, PLANET.

SATI taps into the need to address poverty and create decent work and economic growth, through adopting the cluster development principle, and contributing to the growing organic food, and carbon capture and sequestration markets. It seeks to be inclusive, and enables those living within rural communities to have better quality lives and become financially independent, for the third pillar, PROFIT.

Figure 5.1 Imagination and empowerment applied into the community which enables financial independence, improved wellbeing and a healthier planet
Source: Adapted from flaticon.com, modified by Sisang et al., (2020)

5.2 Implications and guidelines

Circular learning can play a major role in the creation, adoption and development of smarter techniques that increase the extent of people's ability to enhance resilience, livelihood and improve food security. The development of a circular ecosystem as a pattern of working for cropping, biodiversity enhancement, and learning and disseminating knowledge, has the potential to create many sustainable long-term benefits.

It can contribute to the targets set in the United Nations' Sustainable Development Goals to help end poverty, create zero hunger, enable good health and well-being for all, provide quality education and lifelong learning, decent jobs and economic growth, and make human settlements inclusive, ensure sustainable consumption and production, and act on its impacts.

Not only smallholders or small-scale farmers experience the effects of climate change, we all do. Drought, heatwaves and erratic rainfall are unpredictable and often affect farming and many everyday activities. However, we can plan in resilience to such threats.

Table 5.2 SATI guideline stages

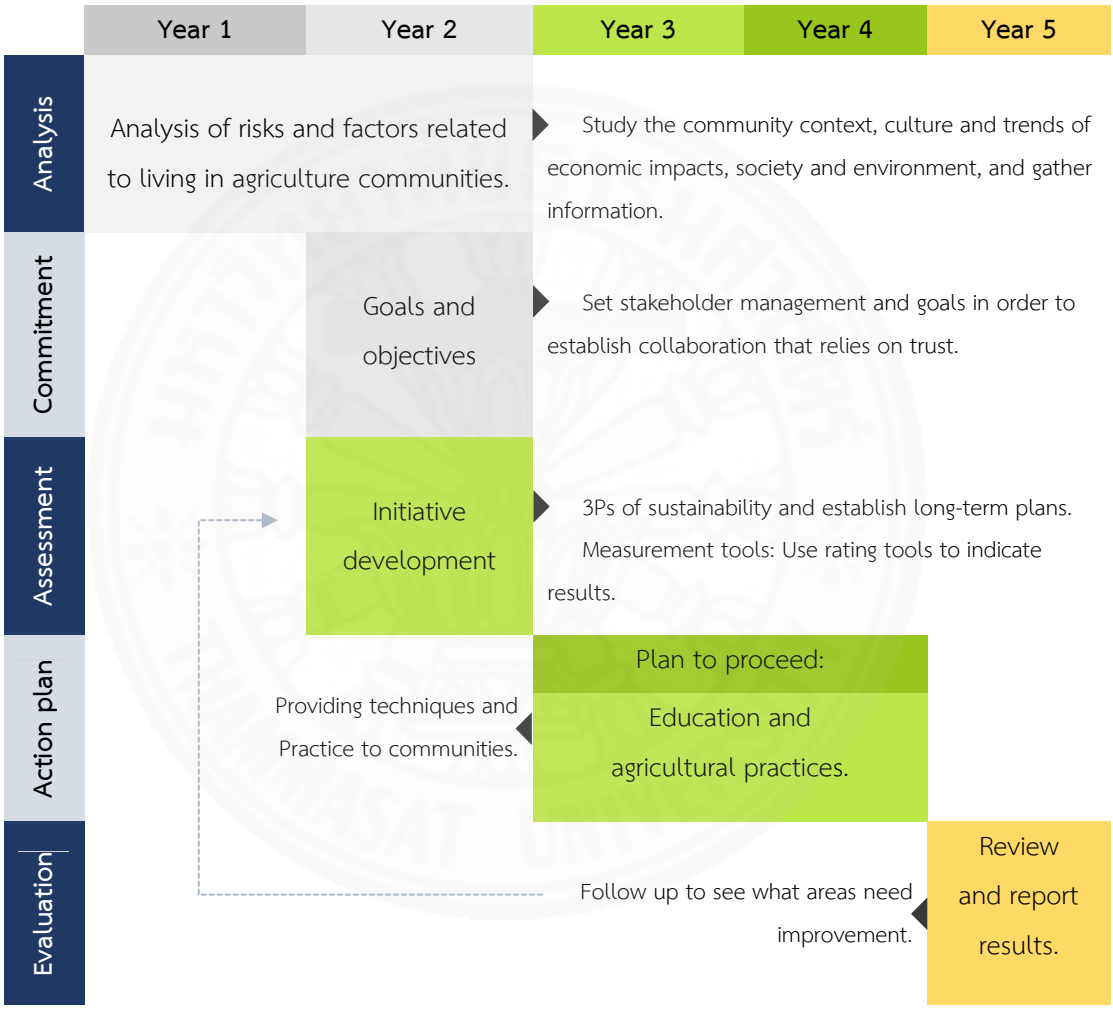
	Step 1	Step 2	Step 3	Step 4
Thrive Community - Based	Education of children	Multi-generation approach	Social mobility: empowerment, opportunities to earn a good living.	"Two-wings" technology approach, blending the best of both worlds.
Bio-friendly Agriculture	Multi-crops	Avoidance of harmful chemicals / conversion to organic farming techniques.	Improved selection of crops and animals to enable the design of closed loop systems. Agroforestry.	Working in harmony with nature, "Two-wings" technology approach to create maximum benefits.
Carbon emissions	Raise awareness on carbon footprint issue.	Provide information on typical carbon footprints from agricultural activities and how they can be addressed.	Reduce carbon footprint and enhance carbon sequestration.	Carbon positive.
Profit	Investment sought to provide better opportunities for later financial returns.	Investment still required. Any profits from individual clusters fed back into development model.	Focused on phased growth and creating conditions for financial independence.	Financially independent community. Self-funded business opportunities and community growth.

5.3 Suggestions for creating guidelines to enable financial independence

The results and analysis of the research undertaken for this present work seeking opportunities to help improve the wellbeing of Thai farmers and help address the climate change issue through the SATI model is developed on the three pillars of sustainability: PEOPLE, PLANET, and PROFIT. Adopting a smarter organic approach, caring for others and undertaking organic agroforestry can all greatly help with regards to increasing poverty eradication and improving educational standards within farming communities, better addressing the risks of climate change and improving national

food security. It also opens up further opportunities for agritourism. Farming community hubs can be developed to bring people together to learn and share knowledge which can be used as active guidelines for creating a nationwide Thai-help-Thai farming community.

Table 5.3 SATI Business overview



Businesses should always be aware of the effects that they can have on people and environment, and that it is highly important to strengthen themselves to cope with any change and risks that may occur. If planning to develop matters within five years, it is possible to simultaneously manage existing risks and create opportunities to compete in the market.

Starting with personnel in the community, they need to understand their community context, assess the potential risks and opportunities, and then analyse the relationship with stakeholders to reflect comprehensive operations, so their goals will be clearer. With regards to assessment criteria, these should link to the three pillars of sustainability stage and measurement tools used to foresee how financial viability can be created within the cluster model development proposed for the community. The action plan will be the next step for providing practices including performance monitoring and community resource analysis. Finally, the community should have a compilation of predicted and actual performance results for future helping determine strengths and potential improvements.

For instance, the government can use the proposed tools or recommendations for establishing best practice policies and initiatives for Thai farmers. It can also be used to aid decisions by those who wish to create the sustainable development of rural communities in Thailand. The government and private sector spreading information on the model and give funding could be a best way to help and encourage its progression. This present research is only preliminary in nature and has been developed to indicate the extent of what can be achieved. It should be developed further in conjunction with potential key stakeholders within the community and also through interviews with key specialists who can help refine the model's concepts to take it a step further forward with regard to increasing its effectiveness. Moreover, a funding program can be created to help enable community success. The SATI guidelines can be applied to farmers, and others within rural communities, to enable sustainable growth. Its adoption can help Thailand to become the organics leader in Southeast Asia, and may become an attractive initiative for Thailand's Agriculture Ministry to back. It could even be scaled up in size to allow the cost-effective growth and development of biologically-friendly closed-loop smart biophilic cities in Thailand.

What is particularly important is that those in authority need to be able to clearly see and be convinced of the benefits that can arise to farmers, rural communities, themselves, and the Thai nation in general if starter funding is provided

to allow SATI communities to develop, thrive and become financially independent. Through helping others, they help themselves as well.

5.4 Suggestions for further research

The research undertaken for this thesis provides many examples of how progressive change, and a gathering of knowledge and techniques, can be made to enable the SATI (Smarter Agriculture Thai Initiative) to be undertaken.

It demonstrates, amongst other things, how the model can be used to: help address issues with chemical farming; improve education for children and adults in rural areas; help farmers earn more money through producing organic crops and undertaking agroforestry; help them earn money through carbon sequestration; help address climate change and climate change risks; and used to enable rural communities to achieve sustainable growth and high quality of life for all generations. As part of this, it proposes how stronger multi-generational communities can be created to help encourage smarter growth and economic progress.

The validity of many of its separate components of it, which have come from a wide variety of specialisms, have already been proven in practice. Its novelty in part lies in the way they have been weaved together to create added value and progressive change. A further strength is how it proposes to blending together the best of old and new approaches to create smarter environmentally-friendly solutions. It creates innovation, empowerment and advancement.

Weaknesses of the research are in part due to the COVID-19 pandemic, and its resultant lockdown, which reduced access to, and the availability of, people to take part in in-depth interviews. This means that only a partial picture was obtained from those who it was originally intended would contribute in-depth feedback.

An additional weakness became apparent with the online survey that was used to help make up this shortfall, as few of the respondents were actually active farmers. This is actually to be expected, as many of the poor farmers have little access to technology and also many may be illiterate so few of them are likely to have undertaken the online questionnaire.

5.5 Conclusions

There is a growing market for organic food worldwide, and an urgent requirement to create smarter agricultural initiatives that help address that need and meet the challenges that we face with regards to climate change, rural decline and food security.

The SATI model offers the opportunity for both high-tech and low-tech bio-friendly solutions to be applied and developed to regenerate rural communities and the agricultural industry whilst aiding the health and wellbeing. Its application can help increase long-term growth, create financial independence, empower individuals, improve education and also aid mental and physical wellbeing within rural areas.

SATI can work in greater harmony with nature, increase resilience, reduce risk, encourage crop diversity and adaptability, enable enhanced carbon sequestration, increase knowledge dissemination, and enhance local area development to a far greater extent than is typically achievable.

SATI's widespread adoption could also significantly, and cost-effectively, help Thailand to achieve its sustainability goals whilst boosting its GDP. Initial government investment in SATI would act as a catalyst to help farmers and rural communities more dynamically address the risks they face and help create an even more dynamic Thailand 4.0.

The integration of the resilience concept in the SATI model will also help increase growth, education and mental/physical wellbeing within rural areas. It will also build on the principles of the late King's work. In addition, initial government investment in SATI would act as a catalyst to help farmers and rural communities more dynamically address the risks they face whilst better recognising what they are capable of achieving.

5.6 Limitations

Working within the limitations set by the model, time and accessibility, the researcher initially planned to undertake a number of in-depth interviews to further explore the farming process, in addition to thoroughly analysing the lessons learned from successful cases found in the critical literature review. During the interviewing process, each of the interviewees had their own time limits for participating and providing answers. This restricted the scope and depth of questions that could be asked during the farm visits. Additionally, the COVID-19 pandemic severely restricted the extent to which such work could be undertaken and the number of locations that could be visited due to the need to apply social distancing and self-quarantine.

To help counter this shortfall, an online questionnaire was then created. However, there was a low number of respondents to this initiative. Possible reasons for this include the fact that due to the COVID-19 crisis many farms are short of labour, and /or experiencing distribution problems which means that time, especially just now, has become a very valuable commodity for them. Additionally, a further potential reason for low numbers is that many of the farmers who would be likely to benefit most from the SATI model have little experience of using technology and undertaking online surveys without assistance.

5.5 Future research needs

Thailand, like many other nations, has suffered as a result of the COVID-19 pandemic. There is an urgent need to ensure that it can revitalise and revive its economy. One of the ways it could do this is through SATI helping increase its production of organic products, and developing new smarter, more innovative, ways to do so that generate increased profits, whilst helping promote good health within the nation.

Due to the COVID-19 situation, many people are becoming more interested in farming and are aware of the worth to develop the potential of farmers' groups, to increase stability and income, and there are changes in people's behaviour to become more aware on health and safety, especially food security. SATI if developed further can enable farmers' communities to come together and use their abilities to overcome any barrier, create fairness and survival for people in agriculture activities, and as be part of the bigger picture by becoming a smarter organic knowledge hub for farmers and communities throughout Thailand. It could even be undertaken with regard to the development of resilient urban agriculture. Investment is need to help undertake further research into how such matters can be best and most cost effectively accomplished for the greatest good.

Additionally, it is proposed that an important topic for future research involves assessing the potential of each area in terms of what can be done in order to help best develop each rural community. Each local area can proactively address decline, grow with greater richness, have greater sense of community, have greater equality, become more populated, complex, and interconnected whilst working in harmony with nature in response to its own unique set of environmental factors. Being mindful of what really matters can create great dividends. The SATI approach helps this be achieved.

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APPENDICES

APPENDIX A

THE INTERVIEWS RECORD

(1) Key Questions for Interviewee No.1: K. Pui, Officer in Thai Farmers Learning Center in Suphan Buri Province, Thailand.

Can you provide some information about farm operations?

- Lifestyle and Spirit of Thai Farmers – Na Hai Chai learning centre was established in 2015 since when it has become a popular farm-tourism attraction and provides a variety of activities for visitors, including various hands-on activities. It has a zone that is provide farmers for cultivating and selling seeds back to those farmers for planting.
- It buys that seed, processes it, transforms it by screening for moisture and checks rice husk (chaff), packages it, transports it and sells it to farmers all over the country.

What kind of plants you grow in this area?

- We focus on planting rice varieties, especially off-season rice crop (low light tolerant). Without light, a plant can be able to produce and grow throughout the year. But the disadvantage for our farms is it will not be resting for later cultivation.
- For essential minerals, we use NPK fertilizer to increase the nitrogen, phosphorus and potassium in the soil because it needs to be absorbed in the roots of plants.
- As for other part of vegetable gardens, we represent ourselves as an ecotourism attraction for student field trips, and families or for individuals who like to exercising and do biking.

Can you describe the physical qualities of rice varieties?

- We can classify type, varieties and forms of rice by the characteristics of each species as this information has classification in the beginning. Each of the rice fields has a different age, dividing into early rice which will be aged from a

minimum of 90 days and late rice which is up to 120 days. “The longer the rice is, the more flour it produces and larger it becomes.”

- The characteristic of Rice Embryo Development will look round and have grains inside. Now we are in the process of waiting it to come out where the nutrient is obtained from photosynthesis under artificial light and water source.
- Oryza sativa Linn Rice (Khao chao) can be grown in the Central region and the Northeast region which we call a second rice cultivation. For an annual rice cultivation (Jasmine rice), which sensitive to light, will produce only in in-season rice fields. The sticky rice is grown in the North of Thailand.

When does the rice-planting season usually start?

- It depends on when you planting and the age of the rice varieties used. If you are planting in January, you would be harvesting in March, a 90 days period. Mostly our rice varieties can withstand any temperature and conditions they are likely to be exposed to except at the flowering stage because most weedy rice will bloom and damage the rice.
- Our plants respond to the weather conditions. If water is not enough for rice field trunk and its nourishment, and faces dry weather, it may cause severe damage to crop properties and our farmland.
- Our farmworker used to use traditional storage for storing rice, but now the owners have brought machinery to help control the amount of water and harvesting.

Do you use any chemicals on your produce?

- Organic farming could be done, but it is difficult. The insects will come if our rice field does not use the chemicals others use. We actually use agricultural chemicals, but we ensure everyone gives the correct dosage at the necessary stage. Also, we use it during the seeding period when the rice is still immature, like giving vaccines to a child.

Smarter idea

- After using water for 30 days, we have a procedure or practical approach for water saving by use PVC pipes to measure groundwater levels as a water

controller. Then we don't add water to rice in order to let the rice redistribute itself which it is a method of teasing rice by King Rama IX.

- This method helps the rice bran to sprout as much as possible and increase new roots to find more nutrients for itself. If it cannot do so, our farmers will release water.

12 species of rice plantation

- We make a trial field of rice varieties to check which of rice may produce and be suitable for any season. For example, there are 12 rice species (3 rows per 1 species) in this field. When the customers come to check, we will assess and suggest which varieties are suitable for planting and which species are not. As we are seed sellers, we like an option for farmers, and we help them to make the right decision by showing and clearly comparing the characteristics of rice as well as the different of species and demonstrating the growth duration it takes. We classify types of rice by taking 20x30 gaps between the same species and other type of rice varieties.

How big is your farm and what do you presently grow? And what is the meaning of rice buckets?

- Normally, most of the rice weight in the rice field is 1,000 kilograms per rai, which equal to 1 ton.
- 1 rai must be 100 buckets which is equal to 1,000 kilograms.
- For 50 buckets (500 kilograms), we called "Bhan", and 1 buckets wagon will equal to 1,500 kilograms.
- In one year, we can sell for over 7,000-8,000 tons.
- We have the moisture meters by taking 50 grains of rice into a grinder and we measure when it becomes brown rice, then we can know the moisture inside per seed and can measure this as an average of the total which is the value of optimum for storage which is 11% (very dry).

Key Questions for Interviewee No.2: K. Ann, Officer in Thai Farmers Learning Center in Suphan Buri Province, Thailand.

Can you provide some information about farm operations?

We raise animals as our owner's preference and practice its expression with animals such as buffalo. But we do not use as them for farming activities or as animal tractors. We just provide the traditional knowledge of how buffalo are useful for olden method farmers.

You have mentioned people visiting here, who else comes?

- We welcome various people who come for observational study, such as school pupils, college students, those in the private sector, the government sector, the Subdistrict Administrative Organization (SAO), and foreign government agencies to review issues about rice farming, technology in seedling production, rice varieties and farming concepts. We emphasise the last King's duties and activities as related to developing rice farming. In addition, as a member of the private sector, we help the majority of government agencies by consulting with them on how to do rice seeding. Recently, our owner became a member of the global seed selection committee.

What are the plans for the future?

- The owner plans to build a residential hotel that will provide banqueting services and wedding arrangements.
- The conditions provide for farmers to join us in purchasing our seed, which has a rice inspector check it and the farmer has to accept the conditions given by the Department of Rice. If bought, it will get a higher price to sell at the mill. The farmers will receive approximately 2,000-4,000 baht and 1,500 baht per person for paddy seedlings in agricultural fields.

What is the main factor during this farming time for loss in capital?

- Now we have insufficient water to be able to deal effectively and sell rice seeds during this season (March).

How do most people know about this place?

- Most of visitor know about here after their searching. We have taken advantage of being where people drive through after they finish traveling. Moreover, we are a center of tourism-activities with an open restaurant, café, gift shop, and areas for exercise. Most of them come here as family groups especially during public holidays and school holidays.

Key Questions for Interviewee No.3: Mr. Nithat Charoenthamraksa, the owner of Lifestyle and Spirit of Thai Farmers-Nahai Chai Learning Center in Suphan Buri Province, Thailand.

- Since I studied at high school, I went to Kaset Fair at Kasetsart University with my teacher and learned through farmers' agricultural experience which inspired me to learn about agriculture and farming methods, and become a gardener. Gardening is like you apply the ideal landscape painting into agricultural forms. In my views, a house without garden cannot be fulfilling.
- My father (Mr.Chai) was paralysed so I had to take over his business that used to buy rice. I was afraid of being a debtor as it would make my life unhappy. I asked my father to change into the rice seed business which resulted in higher earnings than I expected.

What is the meaning of "Nahai-Chai" and the origin of Nahai-Chai farming?

- Na-Hai-Chai (Mr.Chai's farm) is a symbol of the honesty in his work. He wants to make the world know his father and wants his name to be known along with Thailand country, both with Thai farmers for being the source of good quality seeds and for becoming a learning center where people can come to learn and do things effectively.

The origin of Nahai-Chai farming

- Actually, it was since my small family business that was involved with collecting rice seeds for commercial purposes and encouraging farmers to produce rice varieties correctly. Our responsibilities are paddy-purchase, specifying quality

and moisture content and packaging as ready-to-use for farmers in order to use as seed for planting.

- Traditionally, rice varieties have long been Thailand's main food crop for household consumption, and farmers have used traditional storage for the rice seeds for generations.
- The essential first step of rice produce is how to make it have good purity, then you will see the ears of rice bow their heads at the same period which result rice grain quality and good productivity, rice milling and expect that the value of rice exports will be successful.
- My father formerly ran this farm as a paddy rice buyer, in order to become accustomed with paddy rice and farmers in the form of purchasing. We give reserve funds for fertilizer and medicine expenses to those farmers and when it is time for harvesting, we off-set the debts so, our farmers can use their remaining money or it can be rolled over to next month.
- When my father became paralyzed in 1995, I inherited the family business and changed father's business practices from offering loans money to seeds production with selected farmers who were efficient and diligent. Then we selecting the small seed of 4 wagons a day and started to bring a rice variety which is the main species from the Rice Research Center for farmers and look after it. We also encourage the farmers in agricultural knowledge, building greater trust in the produce and guarantee that growing rice with us is worth more than selling to the mills industry. The higher the productivity, the greater the price and income they can get because we set the price of the seeds and we ask them only to follow our criteria.

How do you get to know and select your farmers?

- We search for farmers within 100 kilometers without waiting them for come to us first. Then we offer a good proposal and provide a better and higher return, and they might invite others. Another way to find people in in the province is usually in the temples because they would know each other, know their

address and know who produces a good crop. Then we ask for a permission to see the rice field and invite them to join.

- If the whole grain gets complete and possesses good quality, we will buy rice varieties from the Rice Research Center and provide seeds for farming the next time round. If it follows our farming practices to grow rice (by remove grass whether mutated rice or wild rice) and passing the trials, we will give a reasonable price. Only 30% of farmers do not pass the trial because they are not giving attention and being honest.
- Whether our rice is good or not, depends on the quality of rice germination. We cannot improve the seeds after harvesting so our farmers must be diligent and effective enough to obtain good quality seeds. Also, we use 1.9 million separators from the USA to separate the good grains and maintain purity if the machines are still good. We let an efficient farmer inspect the farmers' rice fields in order to evaluate and measure the risk whether it is perfect or must be developing more, and with machines concurrently.

What are the barriers, obstacles, and challenges you have experienced?

- The big problem farmers are facing is with weedy rice (ejection or bounce rice) infection during continual farming. The characteristics of weedy rice are the red color of its pericarp, resistant any disease, and cover other rice growth and yield in the rice tillering stage. Farmers could not harvest and clear the land because all seeds had fallen. The more types of weedy rice, the less effective it would be, which causes damage to the rice production. Therefore, if sold to the mill industry, they would cut down the price. So, farmers have to sell weedy rice for livestock feed at a cheaper price.
- Broadcasting method or direct sowing rice culture are motivating the growth of weedy rice which look similar and cannot be separated. Most farmers use their techniques to seek and remove it, which can be observed when sampling and seeing as red seeds.
- We build farmer's confidence and make agreements even if seed cannot be sold. Finally, we obtain a maximum of 400 agriculture household members in

approximately 15,000 rai. However, we are still facing drought and a price drop crisis which result in less sales of paddy rice. We have to adjust ourselves by selecting only 200 families in an area of approximately 7,000 – 8,000 rai so that we would have opportunity to sell.

What is your solution to get through such crisis? How have you overcome these?

- I went to Lat Lung Kaew District, Pathum Thani Province and found the indirect seeding method that cultivating by pick young plant on the transplanter machine and follow by Kubota. If weedy rice grows up, unskilled farmers can be easily to find and eliminate them. However, farmers must ensure a water control system in their rice fields. This idea has been applied in our rice field in order to avoid such weedy rice.
- After the weedy rice crisis, we are facing drought, seed trade conditions which effect on high spending costs but drop in the rice market. Those farmers have to had cost for indirect seeding by 1,000 baht per rai to motivate farmers to join.
- Whenever there is less turnover and less capital, I start thinking and brainstorming. Whenever water comes, I search for wood and find leftovers to use. We should prepare and adapt whatever situation will come.

How is your farming business?

- The group of students who came here are not what I expected. I went to Taiwan and saw the solution for seeds production and I see the potential that could create such a benefit. If bringing this method to Thailand and building a learning center and allow farmers to come, it is no different from Taiwan field trip.
- I adapted Taiwan's planning process and methods to my farms by purchasing machinery costing over 3-4 million baht. It took almost a year to learn practices and cultivated the quality seedlings that Taiwan made. Only 0.1% of 10% of wasting.
- Personally, I prefer this size of business as well as the farmer members I have but it might not be enough for the quality of farming business.

- When the seed business is temporarily stopped there are no sales and no money. I have more time to think of something else by bring our farmers, farm officers and employees to practice their skills, including thinking, planning, attitudes, and preparation for the next stage. I set the goals for protecting the rice species and to be able to more successful than other farms, at least within 5 years and also aim to increase our capacity by producing the best germination and being an agricultural tourism spot in the future which is better for all.

Where did you gain your farming knowledge and how do you think it could be improved?

- Raising animals are my own preferences and what I know the most, whether chicken, ducks, or geese. From my point of view, animal farming is a form of new agricultural theory based on the principles of King Rama IX that can be done and have measured related to how well it has been prepared. I studied about agriculture until the high school, which was all agricultural basic, including digging wells, raising catfish and chicken, laying grass and gardening. Apart from that, I have learned through my experience and applied the knowledge I have gained.
- I believed that agriculture is not that bad and reveals nature's hidden beauty. The child or its family could get something from here, may be finding their personality, that they are animal lovers, or even prefer to grow crops and vegetables, and undertake other activities. These things may inspire them to have a love of agriculture and create value.

Do you use any chemicals on your produce?

- I used to use organic agriculture methods, whether using Neem extracts against several insects or wood vinegar, I pretty sure that we cannot grow crops without using chemicals.
- If we aim to grow vegetables (such as Chives, Roselle, Eggplant, Paprika) without chemical use, it could be safe for consumers and succeed. However, other endemic plants (such as Kale, cucumber, Yardlong beans, Cantonese vegetables) still need those chemical even its not for sale.

What do you think of farmers who are unwilling to use new technology?

- We cannot define with their ages or thoughts. Those farmers have different perspectives, some of the older farmers are willing to learn and apply modern technology, some of them are not. Most of the new generation understand the theory but are unable to put the theory into practice, such as observing diseases and knowing the amount of chemical that can be used in farming. If they do not get experience through learning from older farmers, they will probably not be a success in farming.
- The experience through beliefs is also a personal perspective. Some farmers have used the traditional methods and found their worth to be proven though many generations. It is therefore my duty to educate farmers' knowledge on practicing correctly.
- There should have an agency that is willing to help those farmers of all ages, and teach them how to applied such technology into farming practice.
- Not all farmers, especially older ones, are open-minded. They have been in the group who helped Thailand to be the best rice exporter in the world, but that was almost 30 years ago. Now they are all around 60 years old, so what would they do if I did not hire them? For example, farmer families with children spend more on education and personal things such as buying motorcycles. If they do not have enough money, they borrow. These is what happens through the farmer's life.

How about your perspective on old farmers?

- Although many senior farmers or older farmers are getting tired of farming, they still have an idea and require someone via telephone to check their farm, but may be not in the next 10 years. Thus, we must find a team that has uses potential as well as using technology and machinery in order to replace and result in higher productivity and lower costs.

How do you define yourself as related to risk assessment?

- I give them an advice, evaluate their farm and results, and how much they could do with full responsibility. In my view, the new generation of farmers is

still not as patient as previous generations were with regard to helping the elders in farming and that is no way to learn as much as before.

- I define myself as agriculture advisor on how to undertake rice production or grow crops in the right place. And I predict that may have a planting team or advisor that could help take care of the farm to ensure it is successful. But now we can only start out as contracting this which does not look after the whole process.
- The question is how to make the team strong? Farmers cannot handle the unexpected weather like they used to be able to do, as well as the non-stop social media access.
- If there was a drone team or a seed production team that can be apply the technology and prepare the farm, it could be better.

What skills and training do you think smarter organic farmers, such as those involved in smart agroforestry need most to be successful?

- Farmers should learn to be self-reliant, ready to experiment and learn as much as possible. Additionally, the decision based on reason and results is what the most useful as well as decision-making. If there anything harder, I am willing to help.

What about the possibly about agroforestry farming that could be involved with your farm?

- Growing with a variety of plants is acceptable and will create an ecosystem. For example, if growing kale, insects will be a problem. But if we grow other crops such as peppers, eggplants, basil crops, and peppermint, other insects will come to help decrease other types of insects.
- But this method is not suitable for people who do conventional agriculture for a business. In my opinion, crop-rotation is more useful for agriculture because growing the same plant will bring the same insects. If this season we grow rice and next season we changing to grow sugarcane, it will consume different nutrient in the soil and we can rest from planting previously. Those insects that used to eat before would not know that we already change, and it would come

again. What we obtained from the crop-rotation is we get better quality and more nutrients after shifting.

What is the possibility that could become the institution for the next generation?

- We should consider more on its ability and how it can be used to solve such situations. I intend to build a school for the young generation (Primary school – High school) in the future. This range of age are willing to accept and learn the new skills. I might divide the duties for 5 groups. The first group welcoming the visitor, volunteering to create human relation services, and practicing them to take care of tourists. The second group looks after fruits and vegetables in the farm, followed by the third group that learns about how to fish. The fourth group does farm, and the fifth group takes care of cleanliness. Every group must be circulated and scored, have limited phone usage, and have practice in living together without conflicts.

Do you think farmers should have a second career after they retire?

- From my statistics, one cycle of farming requires only 10 days at least to stay in the rice field, and 1 day has 24 hours, it means that we spend a few hours with the farm. They will have a time to do something else, such as take care of their child or their family. The question is what the other job they can do that would be appropriate for their age? It might be something, or generated from their hobbies in tandem with their main work. Most of them are diligent and can be a model for the next generation.
- The signs of global warming are observable and affect the world's environment, and now there are organisations or charities that are ready to help address these to meet the SDGs goal.

Do you want to be more adaptable to every situation, or see what your organisation can be part of?

- It is obvious that the global climate situation is affecting on our life. In my opinion, the best we can do is be more resilient to those impacts through precision farming. It useful for agriculture and empowers farmers to start

planning and risk assessment in any weather and water quality control, such as replacement of diseased plants with healthy plants.

Do you wish to do agroforestry instead of regular farming?

- I prefer grow crops that can be substituted for rice cultivation but am still not receiving cooperation from other sectors. However, the competition in the global market is still high despite the drought and insufficient water supply. For example, comparing the other countries, Vietnam has a low cost on planting while Myanmar have diligent hard-working people and land that is suitable for planting. The chances of winning against Vietnam, in particular, would be difficult.
- We might experiment by use foreign plants to grow on our land and see which plant would survive and increase the value, or maybe grow coffee trees instead. After experimenting and if the result is acceptable, then farmers can continue to experiment.

Which is the most difficult in agriculture? Organic farming or Chemical farming?

- Actually, it is down to the farmer's perceptions. We cannot change their mind to agree with us. I have brought the sustainable methods by King Rama IX to them for creating alternative ways and showing how they can make what they do as cost-effective as possible. If this works, they will come and join us.
- Most of Thai farmers that I have had experience with prefer to avoid conflicts. They remember that they have been successful with conventional farming on fertile land and in good weather. Thus, convincing them to be more open-minded are the first things we must consider, and bringing them to learn to be a leader farmer is what we plan for the next phase.

Have you ever experienced conflicts with other competitors in Thailand? In the matter of seeds selling or companies that steal your farmers?

- I have built network relations as well as trust with our farmers for over 7 years and have never been faced with this problem. In the matter of competition, we must prepare and share the burden and always find the market that can be provide such quality for our farmers.

- Also, I change my strategy by adding a secondary brand that can able to compete in another market. The reason why we must have it is because it can be help support us during the time we end work with seasonal seeds.

Other suggestions?

New generations still need to rely on experience and learn from previous generations. Most young people have strength but lack experience. If the experience from the previous generation is brought together and combined with the new generation, it can be compared to a successful sharing household that increase their abilities and strength for farming.

Key Questions for Interviewee No.4: Mr. Chunchai Pakdeesusuk, Head Barista at Red Diamond Specialty Coffee.

Why are you interested in coffee and coffee processing?

- Because I want to learn about all the processes in making coffee, for example, if we produce by ourselves, what must be done? Or what do the roasters think? What are they concerned the most about while they are roasting? These knowledges can be generated and are steps which we also can give and share endlessly. The more the company grows, the more the competition in the organization will increase, and people must learn all the time.

Is it true that most of farmers who start to cultivate are new generation farmers? Are they receiving knowledge through culture or generation, or growing vegetables before planting coffee, or coffee planting since they started?

- Coffee is an economic crop in each area. Originally, farmers often used to plant opium which is illegal, so they switched to grow coffee plants instead to make more income. When it becomes their main income, they grow other crops, such as strawberries and avocados. These are not like mixed agriculture because they might only get income from the coffee for the whole year.
- The definitions of the new generation and the old generation can actually contain both. We called **the old generation those with the willingness to learn in the modern world**, or maybe the old generation but old fashioned.

And the new generation that are old fashioned, or **prefer the modern things**. Most of coffee that we choose and select as specialty coffee is usually from both groups of people that prefer modern things. Certainly, the coffee price will be higher than usual.

Do most farmers use chemicals or not?

- I have to assume that chemical fertilizer or pesticide is added. Our disadvantage is that farmers in the North develop themselves quite slowly and took it easy with ways to change as stopping the use of insecticides immediately will cut too much income. When there is no money or no output, farmers will have no way out.
- Slow change usually occurs with modern farmers. But being more reliant on nature, the coffee price will continue to increase. Our Thai coffee green bean is quite expensive when compared for quality.

You have visited the coffee plantations in Chiang Rai and have been involved with farmer activities while harvesting coffee cherry, how do they store it? Do they use machines?

- Thai coffee trees can be grown on a ridge which is very steep, unlike Brazil which they are planted as a row on the plains. (Most of the plateau is located in the Laos country but Thais plant on the hillsides). A machine is used for the coffee processing.

Is it possible to not use the machine while grow or processing?

- Absolutely not. One coffee tree can produce a lot and requires a lot of time to peel a cherry skin out of the beans before processing. Therefore, the machine will help reduce time and increase convenience for all, for example, to measure the temperature, or the temperature controller that will help the output to be of higher quality. The use of good technology helps increase seed quality.
- In my view, during the drying process which is one of the methods of processing coffee, it must be laid out in the sun. It would be good to have a machine that

can flip the seed automatically, or a seed dryer. However, there is no research to see whether it affects the taste or not.

- The issue between the processing is the coffee maker and the processor (farmer) are not the same person. There may be some conflicts because each person has different potentials, attitudes, and perspectives.

So, where can we gain the best coffee knowledge? Especially if each person says that what they do is the best and there may be conflict between some ways or ideas.

- First, you must have an experience and people that can help each other. You cannot do success by yourself, such as if nobody says that sour coffee is delicious, you will never drink it. So, there must be someone that can explain to you how coffee is good along with the experience you gain, which is a result of our own connect and proven experience (Which type are roasted, which type are not. Sun dried coffee or dry while using the machine? Which one good or bad?). Making a good coffee you must be tolerant. Most people who are top champions decide to do the whole process because doing it by yourself is easier, and changing others is harder.

How can you contact the farmers?

- We are not only a seller or buyer, we have to know each other in order to know their characteristics, attitudes and behaviour, how open-minded are they? How could we connect or adjust them? How can we have the upper-hand over them or be on their side? We look at the long-term because in this relationship we meet them only once a year.

How many years does it take to build good relationships with farmers?

- Building relationships is important between our firm and farmers. The storefront should have someone who can check the quality of coffee beans, goods and production. For example, if we taste the coffee to check the quality and taste, if it is not good, we will have to give this feedback back to them and see how the feedback gradually changes things. Sometimes we need to order seeds in

the medium quality because the extremely good quality does not quite have enough demand in the market.

- Most of Thai coffee green beans we receive from our farmers, but for the coffee from different countries we connect through a dealer because contact by ourselves might be difficult and cost us a lot of money to do.
- Without the COVID-19 pandemic and still open for 10 branches, on an average month we buy 700,000 – 800,000 baht to 1-million-baht worth of coffee beans per month and have a margin reserved for use.

What if the green beans that sent are not the desired quality?

- The whole process must be completed before we taste it. The point is if we give feedback to them that it is good, farmers will do the same and will sent other lots of coffee to taste, or maybe as a gift. We have to believe that they are professional enough and there are not any mistakes.

What are the problems, obstacles, and challenges that occur?

- The obstacle we face are about buying coffee from a trader. Sometimes we did not taste it because we are in a hurry or lacking something. The problem usually occurs because we have to manage money which is directly to our disadvantage, the payouts are dependent on the owner who is the sole decision maker.
- Coffee must be ordered in advance (1 year for use in the whole year), which uses a lot of spending capital and incurs high cost. If we do not order annually, we have to order and reserve continuously. (For example, we assume that 6 units are booked per 2-3 tons which has 20%-30% of deposit per units that is equivalent to getting 10 tons of coffee. Deposits of this value with foreign coffee will be getting a far higher price.) It seems that ordering far in advance is quite the wrong cash-flow principle to use. The correct way in my opinion is to stock for short-term to use the money for other matters.

What is your point of view while you teach such a technique to others?

- Brewing coffee or tasting coffee is like you play a game with them, it can be tricky and it can be brilliant. I try to give the best understanding of the context

of coffee that you can play everything with them. There are lots of spaces to move and no need to lean in any way. Also, I try to explain to our customer that we can applied even if it comes from a different country or processing. No matter we teach you, you have to try. You might follow the theoretical route or follow the experiences of seniors, or do it like yesterday. If it shows that this theory actually works or is similar, then it is fine. But if we totally concern even the water that we measure by us TDS water measurement, the taste will not be the same with many factors (water, person taste experience, peak flavour). Therefore, the fastest things to do by yourself is ask and learn.

- The SCA examination is not so important that you have to take the exam because finally it costs a lot of money. The thing that I can do the most is educate them.

Other suggestions?

Weather conditions affect coffee bean cultivation. We might not need to have our own farm but we need to have a farmer that can be our friend and be ready to support coffee the way we think about it, it will be faster than we have a farm. And we will gain the knowledge from them. But we must show that we are not doing for this for the benefit of our organisation, but to push Thai coffee forward in the way that everyone accepts. Second, build the relationships between us and farmer, and think from the farmer's perspective too. We show the value and how we can develop through the community. If that day is possible, we will be able to make a good coffee and both parties will be happy. Coffee is like a person, having people to share and collaborate with is the best way we can move forward.

Table A1: Gender and age of the respondents.

	Thailand (n = 52)			**Other countries (n = 3)**	
	Bangkok	Vicinity	Another province	Australia	USA
Gender					
Number of Males	10	3	7		
Number of Females	20	8	4	1	2
Age (years)					
>18					
19-25	9		2		
26-33	1				
34-40	3	2			1
41-50	6	4	3		
Above 50	11	5	6	1	1

Table A2: Education level, career and salary of respondents.

	Thailand (n = 52)			**Other countries (n = 3)**	
	Bangkok	Vicinity	Another province	Australia	USA
Education level					
High School	1				
Vocational Certificate	1	1			1
High Vocational Certificate	1	1	1	1	
Bachelor Degrees	16	3	6		1
Master Degrees	10	3	4		
Doctor Degrees	1	3			
Career					
Student					
College Student	7				
Employee	10	5	3		1
Business Owner	5	3	1	1	1
Farmer / Agriculturist	1	2	1		
Unemployed	2	1	4		
Others	5		2		
Salary					
< 15,000	5	1	1		
15,001 – 30,000	6	4	2		
30,001 – 60,000	5		1		
> 60,000	5	5	2	1	1
Prefer not to say	9	1	5		1

APPENDIX B

THE ONLINE QUESTIONNAIRE

SATI is a specially proposed inclusive and ethically-driven agriculture / agroforestry model that is being innovatively designed and developed to help improve the wellbeing of farmers, their families and the communities they live in within Thailand.

This survey is being undertaken to investigate and gain a better understanding of the lives, thoughts and perceptions of individuals living in Thai farming communities, and develop a deeper understanding of those who undertake, or wish to undertake, more resilient integrated organic farming and agroforestry practices. You taking the time to complete this survey is very much appreciated.

คำถามทั่วไป (Part 1: General Information.)

เพศ (Gender)

- ชาย (Male)
- หญิง (Female)
- ไม่ต้องการระบุ (Prefer not to say)

อายุ (Age)

- อายุต่ำกว่า 18 ปี (Below than 18 years old)
- 19-25 ปี (19-25 years old)
- 26-33 ปี (26-33 years old)
- 34-40 ปี (34-40 years old)
- 41-50 ปี (41-50 years old)
- 50 ปีขึ้นไป (Above 50 years old)

เงินเดือน (Salary)

- ต่ำกว่า 15,000 บาท (Less than 15,000 Baht)
- 15,001 – 30,000 บาท (Baht)
- 30,001 – 60,000 บาท (Baht)
- More than 60,000 บาท (Baht)
- ไม่ต้องการระบุ (Prefer not to say)

ระดับการศึกษา (Education level)

- ประถมศึกษา (Elementary School)
- มัธยมศึกษา (High School)
- ปวช. (Vocational Certificate)
- ปวส. (High Vocational Certificate)
- ปริญญาตรี (Bachelor Degrees)
- ปริญญาโท (Master Degrees)
- ปริญญาเอก (Doctor Degrees)

อาชีพ (Career)

- นักเรียน (Student)
- นักศึกษา (College Student)
- รับจ้าง / พนักงานบริษัท (Employee)
- ธุรกิจส่วนตัว (Business Owner)
- เกษตรกร (Farmer / Agriculturist)
- ไม่ได้ทำงาน (Unemployed)
- อื่น ๆ (Others)

ที่อยู่อาศัย (Where do you live?)

- กรุงเทพ (Bangkok)
- ปริมณฑล (Vicinity)
- จังหวัดอื่น ๆ โปรดระบุในช่องอื่น ๆ (Other provinces, please write it below)
- อื่น ๆ (.....)

เกี่ยวกับวิถีเกษตร (Part 2: About agricultural matters.)

ส่วนที่ 2 จัดทำเพื่อความเข้าใจด้านพฤติกรรมเกี่ยวกับวิถีการเกษตร (To understand your behaviour related to agricultural matters.)

คุณเกี่ยวข้องกับวิถีเกษตรได้อย่างไร สามารถตอบได้มากกว่า 1 ข้อ (How did you become involved with agriculture? You can choose more than one answer).

- ความชอบส่วนตัว (Personal preference)
- ถูกถ่ายทอดประสบการณ์จากรุ่นสู่รุ่น (Transferred from generation to generation)
- ปลูกในละแวกบ้าน / คนในครอบครัวปลูก (Growing around my home area / My family cultivates plants)
- ทำเป็นธุรกิจการเกษตร (Agribusiness)
- ปลูกในพื้นที่ของตน (Planting in my own land)
- ทำการเกษตรควบคู่ไปกับการเลี้ยงสัตว์ (Integrating animal husbandry)
- ทำเป็นสถาบันสอนการทำเกษตร (Agriculture institution)
- แบ่งปันความรู้ในกลุ่มการเกษตรออนไลน์ (Sharing knowledge within online agricultural groups)
- อื่น ๆ (Others)

หากคุณสนใจในวิถีเกษตร คุณสนใจประเภทไหนในตอนนี้ สามารถตอบได้มากกว่า 1 ข้อ (If you are interested in agriculture, what type(s) are you interested in? You can choose more than one answer).

- ปลูกตามเทรนด์ในช่วงกักตัว (Growing food during quarantine period)
- ปลูกพืชผักสวนครัว ผลไม้ (Growing vegetables and fruit)
- ปลูกในเชิงเกษตรอินทรีย์ เช่น หมักปุ๋ยเองจากพืชสด ผักผลไม้ที่เหลือใช้ (Creating organic fertilizers from your fruit and vegetable waste)
- พืชเศรษฐกิจ เช่น ข้าว มันสำปะหลัง ถั่วลิสง หอมแดง ข้าวโพด ยางพารา ฯลฯ (Economic crops, such as rice, cassava, peanuts, shallot, corn, rubber, etc.)
- ต้นกาแฟ (Coffee plants)
- ปลูกพืชควบคู่ไปกับการเลี้ยงสัตว์ (Growing crops and livestock)
- ท่องเที่ยวเชิงนิเวศและธรรมชาติ (Eco-tourism and nature)
- อื่น ๆ (Others)

เหตุใดคุณจึงชอบวิถีการเกษตร สามารถตอบได้มากกว่า 1 ข้อ (Why do you like agriculture? You can choose more than one reason).

- สามารถสร้างรายได้แก่ทุกคนในครอบครัว (It can generate income for our family)
- ยินดีที่จะได้แบ่งปันความรู้แก่สาธารณะ (Willing to share knowledge with the public)
- ยินดีที่จะแบ่งปันเมล็ดพันธุ์ที่ตนปลูกแก่สาธารณะ (Willing to share seeds from what we have planted with the public)
- ยินดีที่จะจำหน่ายเมล็ดพันธุ์แก่สาธารณะ (Willing to sell seeds to the public)
- ต้องการใช้เวลาว่างให้เป็นประโยชน์ (Would like to spend free time meaningfully)
- ได้ตระหนักถึงสุขภาพ ไม่ต้องการใช้สารเคมี (Health awareness and do not want to use chemicals)
- ทำกิจกรรมเพื่อสังคม (Activity for social contribution)
- การเกษตรเป็นหนึ่งในธุรกิจที่สนใจ (Agriculture is one of the businesses that I am interested in)
- ชอบท่องเที่ยวในเชิงเกษตร / พักผ่อน (Agri-tourism / Experience nature)
- ช่วยลดภาวะโลกร้อนและสร้างความยั่งยืน (Want to help reduce climate change and increase sustainability)
- อื่น ๆ (Others)

คำถามเจาะจงสำหรับผู้เริ่มสนใจหรือมีแผนกำลังจะทำการเกษตร

(Part 3: Specific questions for those interested or planning to do agriculture.)

หากคุณไม่สนใจในการทำการเกษตร สามารถกดข้ามไปยังหน้าสุดท้าย (If you are not interested in doing agriculture, you can press skip to the last page).

ในปัจจุบันคุณทำการเกษตรแบบใดเป็นหลัก (What kind of agriculture do you currently do?).

- O การเกษตรเชิงเดี่ยว (Monoculture agriculture)
- O การเกษตรแบบปกติที่มีการใช้ปุ๋ยเคมี (Conventional agriculture with chemical fertiliser)
- O การเกษตรแบบเน้นใช้สารเคมี (Full chemical agriculture)
- O การเกษตรอินทรีย์แบบไร้สารเคมี (Organic agriculture)
- O การเกษตรแบบผสมผสานหรือวนเกษตร เน้นความหลากหลายทางชีวภาพ (Agroforestry, with emphasis on improving biodiversity)
- O อื่น ๆ (Others)

คุณรู้จักวิธีการทำเกษตรอื่นๆ แบบใดบ้าง สามารถตอบได้มากกว่า 1 ข้อ (What kind of other farming methods and technique do you know? You can choose more than one answer).

- O การเกษตรอินทรีย์ (Organic agriculture)
- O การเกษตรแบบผสมผสานหรือวนเกษตร (Agroforestry)
- O การปลูกกาแฟ (Coffee farming)
- O การปลูกกาแฟใต้ร่มเงาใหญ่ (Shade-grown coffee)
- O การออกแบบพื้นที่ภายใต้ความเข้าใจในธรรมชาติ (Permaculture system)
- O การบูรณาการโดยปลูกต้นไม้และเลี้ยงปศุสัตว์ในพื้นที่เดียวกัน (Silvopasture system, with trees and animals in the same area)
- O ระบบนิเวศสัตว์บริการ (Animal Eco-system Service. Examples: Weed control, Pest control, Fire prevention, etc.)
- O อื่น ๆ (Others)

คุณได้ทำงานหรือธุรกิจด้านอื่นๆ ควบคู่ไปกับการทำเกษตรของคุณหรือไม่ (Have you got other careers while undertaking agriculture?).

- O ไม่ ตนยึดการเกษตรเป็นงานหลัก (No, I do agriculture as my only job)
- O ใช่ แต่ตนยึดงานเกษตรเป็นอาชีพรองหรืองานอดิเรก (Yes, but I do agriculture as my second job or as a hobby)

คุณเคยเผชิญกับปัญหาหรืออุปสรรคให้ระหว่างการทำการเกษตรของคุณหรือไม่ (What are the barriers, obstacles, and challenges you have experienced?).

Answer:

คุณเคยใช้วิธีการเกษตรแบบสารเคมีมาก่อนหรือไม่ หากเคยใช้ เหตุใดถึงเปลี่ยนวิธี (Have you undertaken chemical agriculture? If so, why change that method?).

Answer:

ในปัจจุบัน คุณได้นำเทคโนโลยีมาใช้ควบคู่ไปกับการเกษตรของคุณหรือไม่ สามารถตอบได้มากกว่า 1 ข้อ (What kinds of technology do you use to help you in agriculture? You can choose more than one answer).

- เทคโนโลยีเพื่อช่วยในการหาข้อมูลหรือในการทำเกษตรแม่นยำ เช่น โทรศัพท์ แท็ปเลต คอมพิวเตอร์ (Technology for finding information on precision agriculture such as smartphone, tablet, computer, etc.)
- เครื่องจักรกล (Machine technology)
- ไม่ใช้เทคโนโลยีใด ๆ (Low-technological approach)
- อื่น ๆ (Others)

คุณเคยมีส่วนร่วมในกิจกรรมเกี่ยวกับการเกษตรหรือไม่ สามารถตอบได้มากกว่า 1 ข้อ (Have you ever participated in training and support related to agriculture? You can choose more than one answer).

- ปลูกเพียงในพื้นที่บ้าน (Just planted in home area)
- โครงการปลูกป่า (Participated in reforestation / growing a forest project)
- เข้าร่วมสถาบันสอนการเกษตร (Joined an agricultural teaching institute)
- เข้าร่วมการฟังสนทนาเกี่ยวกับการเกษตร (Join a meeting / seminar about agricultural matters)
- อื่น ๆ (Others)

คุณคิดว่าการทำการเกษตรแบบผสมผสาน หรือวนเกษตร ตรงกับความหมายใดมากที่สุด (What do you think integrated farming or agroforestry are?).

- เป็นการปลูกพืชเกษตรแซมพื้นที่ป่าธรรมชาติ (A type of agricultural plantation in natural forest area)
- ปลูกต้นไม้ควบคู่ไปกับการเลี้ยงสัตว์ (Integrating animal husbandry with growing trees)
- การอนุรักษ์พันธุ์ไม้ (Plant conservation)
- อื่น ๆ (Others)

กระบวนการร่วมสร้างสรรค์ชุมชนในแบบของคุณ (Let's create your own imaginative community hub!)

หากคุณเป็นส่วนหนึ่งที่จะออกแบบชุมชนการเกษตรอัจฉริยะ มีอะไรบ้างที่คุณจะคำนึงถึง (If you are involved in / become involved in creating A Smarter Organic Farming Community, what are some of your considerations?)

	เห็นด้วยอย่างยิ่ง (Strongly agree)	เห็นด้วย (Agree)	ปานกลาง (Neutral)	ไม่เห็นด้วย (Disagree)	ไม่เห็นด้วยอย่างยิ่ง (Strongly disagree)
การเกษตรแบบไร้สารเคมี (Non-chemical agricultural approach is used)	○	○	○	○	○
การเกษตรที่ช่วยกักคาร์บอนในชั้นบรรยากาศให้ลดลง (Agriculture that helps carbon sequestration)	○	○	○	○	○
การช่วยลดภาวะเปลี่ยนแปลงของสภาพอากาศ (Actions help address climate change)	○	○	○	○	○

การปลูกพืชหมุนเวียน (Multiple types of crops are grown in rotation)	O	O	O	O	O
เป็นพื้นที่แลกเปลี่ยนความรู้ (Space for knowledge exchange)	O	O	O	O	O
สถาบันศึกษาเพื่อยุติความยากจน (Educational place and action to end extreme poverty)	O	O	O	O	O
มีเทคโนโลยีที่สนับสนุนความมั่นคงทางอาหารและการทำฟาร์มที่แม่นยำ (Hi-tech approach that supports food security and precision agriculture)	O	O	O	O	O
แหล่งลงทุนสร้างธุรกิจแก่ชุมชน (Investment source to generate business for the community)	O	O	O	O	O
ความคิดริเริ่มในการประยุกต์เกษตรอินทรีย์และสร้างระบบนิเวศ (Low-tech initiatives are adopted such as applying organic agricultural knowledge and encouraging animal eco-system services)	O	O	O	O	O
การรวมตัวกันของบุคคลหลากหลายรุ่นและต่อยอดคุณค่าให้เกิดประโยชน์สูงสุด (Multi-generation approach to extend value for maximum benefit)	O	O	O	O	O
สามารถปรับตัวต่อการเปลี่ยนแปลงได้ในหลายๆ ด้าน (Resilience adaptation to help survive in any conditions)	O	O	O	O	O
ทำการเกษตรที่เป็นมิตรต่อสิ่งแวดล้อม (Bio-friendly agriculture)	O	O	O	O	O
การได้คืนกำไรสู่สังคม (Paying back to society)	O	O	O	O	O

คุณคิดว่า ชุมชนการเกษตรอัจฉริยะคุณสร้างขึ้นมา จะสามารถเพิ่มศักยภาพของเกษตรกร สร้างรายได้และช่วยพัฒนาชุมชนได้หรือไม่ (Do you agree that smarter agriculture community hubs can increase the potential of farmers, increase their incomes, and help develop rural communities?)

- O ได้ (Yes)
- O อาจเป็นไปได้ (Maybe)
- O ไม่แน่ใจ (Not sure)
- O เป็นไปไม่ได้ (No)

คุณมองว่าการเกษตรหรือธุรกิจที่เกี่ยวข้องการกับเกษตรในประเทศไทย ควรจะมีทิศทางอย่างไรในอีกห้าปีข้างหน้า (In your opinion, what should the direction of agriculture or agribusinesses be in the next five years?)

Answer:

นอกจากการทำเกษตร คุณอยากเรียนรู้ด้านอะไรเพิ่มเติมที่สามารถเพิ่มศักยภาพในตัวคุณ (In addition to agriculture, what additional skills would you like to learn that can increase your potential?)

Answer:

ข้อเสนอแนะเพิ่มเติม (Other suggestions?)

Answer:

BIOGRAPHY

Name	Miss Kanphattasinee Sisang
Date of Birth	January 1, 1997
Educational Attainment	2019: Bachelor of Science (Design, Business and Technology Management) Faculty of Architecture and Planning Thammasat University

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Sisang, K., Jamieson, I., Wongwatcharapaiboon, J., & Chulerk, R. (2020). SATI (Smarter Agriculture Thai Initiative): A Smarter Organic Farming Model for Thai Farmers. Built Environment Research Associates Conference, 11th, 25th June 2020. (This received a Runner-Up Best Paper Award at the conference).