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PISAI

Participatory and Integrative Support
for Agricultural Initiative

Key Elements and Lessons

To be Learned of Practical Sustainable Production at Small, Medium and Large Scales in Thailand and European Environment

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A Rationale for Double Degree Master Program Emphasizing Sustainable Agriculture under the Support of PISAI (Participatory and Integrative Support for Agricultural Initiative)

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PREFACE

This report is an important component of the PISAI Project that aims to strengthen the important role of higher education in supporting sustainable agriculture in Thailand and enhance the employability of graduates. More specifically, the Project aims to support networking employers/professional sector; improve the curriculum in selected universities in Asia; and enhance the Asian students' soft skills.

The report includes up-to-date knowledge on the status of agriculture in Thailand (especially various forms of sustainable agriculture), the roles of government and private sectors, the influences of educational institutes on sustainable development, and perspectives on sustainable agriculture and its role in the larger issue of sustainability. European agriculture and approach to sustainability was reviewed so that the successful practices could be applied to the Asian situation. All these will all be essential in laying down the foundation for addressing important issues in PISAI's double degree program which includes four modules. The report will be used as a guide for professors and students to pay serious attention to practical solutions to agricultural problems that will truly contribute to it becoming sustainable.

Most of PISAI Project students have not yet entered the workforce, while others are already working professionals who are doing a master's degree in one of the many agricultural sciences. Four universities in Thailand cooperated with four European universities in putting together the 4 modules that make up the program.

Outline

1. Introduction **7**

2. Sustainable Agriculture and Food Security: Government Academia and Private Sector Roles **9**

2.1 Sustainable Agriculture- Definition, Principles 9

2.2 Sustainable intensification: Agroecology vs Permaculture 12

2.3 Roles of Education and Relevant Institutions. 17

2.4 Food Security 20

3. Overview of agriculture in Thailand; roles of small and large farms; impacts of educational institutes on agricultural sustainability **20**

3.1 Agroforestry in Thailand 27

3.2 Sufficiency Economy Philosophy (SEP) Practices to Sustainable Agriculture 31

3.3 Thailand's Best Practices and Lessons Learned in Agricultural Development 38

4. European agriculture and approach to sustainability **44**

4.1 General situation of agriculture in Europe; sustainability approach and EU policy 48

References **52**

Key Elements and Lessons to be Learned of Practical Sustainable Production at Small, Medium and Large Scales in Thailand and European Environment

Abstract

Currently, far too much of the world's population is living egregiously unsustainably. This paper relates some of the issues that are frightfully mis-handled with our conventional agri-food system, and some alternatives to conventional agriculture and traditional education, that could lead us on a trajectory towards sustainability and food security for everyone on earth. We will build a foundation for understanding what sustainable agricultural systems and food security mean, and try to identify the features of such systems, including the roles that should be adopted by government, business, and research focusing on agriculture. In the context of food security, we will define a sustainable system as inclusive of environmental and human needs, laying out the necessary elements. We thus will look at agroecology (which is mainly an agricultural system that takes into account human and ecosystem needs), permaculture (which is mainly a design system that is commonly applied to farms and gardens and also takes into account human and ecosystem needs) and Thailand's Sufficiency Economy and its accompanying farming system called New Theory farming (which focus on self-suffiency and happiness through wisdom and moderation).

As holistic alternatives to traditional education are integral to preparing students to enter agriculture and related fields, attention will be paid to educational programmes emphasizing the practical approach which contribute to sustainable agriculture and food security. Being holistic and student-centred, aiming to prepare students to deal with actual situations in the field, the programmes are ideal training ground for graduates to apply newly-gained perspectives and attitudes as well as knowledge and skills, in situations where lives are at stake.

Keywords: sustainable agriculture, food security, small-scale farmers, alternative education, holism, interdisciplinary

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In spite of agricultural increases, we are now experiencing widespread food insecurity in what should be a world of plenty.
Global Land Outlook (2017)
Improving smallholder farm productivity in a sustainable way has the potential to simultaneously improve food security, improve access to food through higher incomes of the rural poor, and prevent environmental degradation.
FAO (2014a)

1. Introduction

Among the ill-consequences of conventional agriculture that threaten food security, of particular importance are soil degradation, water issues, and declining agricultural biodiversity. FAO (2015) reported on the degradation of soils, the various causes, and solutions to improving soil conditions. It warned of the risk of declining food production and increased food insecurity because most of the world's agricultural soils are in fair, poor, and very poor condition, and that most are worsening. Soils are eroding, increasingly acidic, saline, and contaminated, and accommodate less soil biodiversity, all due largely to population growth, urbanization, and climate change. Erosion takes away 25 to 40 billion tonnes of earth's topsoil each year, and many of the remaining soils lack nutrients. The frightening, yet millennia-old stories that eroded and degraded soil do not sustain human populations are vividly told through pictures and stories in Conquest of the Land Through Seven Thousand Years (Lowdermilk, 1948).

The agriculture sector has an enormous impact on the world's fresh water supply. Two aspects of a United Nations report examining water insecurity will be discussed here, namely water shortages and poor water quality (UNCCD, 2017). The report attributed 70% of global "water withdrawals" (i.e. taking from sources of fresh water) going to agriculture, making it "by far the most important driver of water shortages around the world." This profligate use leaves only about 30% for industry, household uses, other species, and ecosystem services. Agriculture in Southeast Asia uses the highest percentage, due to the flooding of rice paddies. The report said that in the last century, though world population has increased 3-folds, water consumption has increased 6-folds, mostly due to agricultural usage. More and more fresh, brackish, and coastal waters are polluted by household waste, industrial waste, and agricultural run-off. Contaminated

fresh drinking water, in part resulting from agricultural practices, is increasingly unfit for human consumption and agriculture. Since the beginning of the Green Revolution, synthetic nitrogen fertilizer use has increased 9-folds, and is expected to grow further, and phosphate use has gone up 3-folds.

Quan (2011) claimed that within the last 100 or so years, 75% of plant genetic diversity had been lost because conventional farming had devastated the prior abundance of agricultural biodiversity. Mulvany (2016) argued that there are a myriad of sources causing the loss. He cited the following: conventional farming's reliance on monocultures (increasingly on GM crops), which decrease the value and utility of heirloom varieties and breeds; industrial research, which de-values and erodes local knowledge, research capacities, and innovation systems that foster agricultural biodiversity; pesticides, herbicides, and chemical fertilizers, which impair ecosystem functions; industrial property rights, which criminalize small producers who challenge the industrial model; climate change, which puts stress on local crops and livestock to cope with weather pattern changes, making them vulnerable to diseases and pests; and disaster relief efforts that bring industrial seeds and livestock breeds, undermining local agricultural biodiversity. In addition, he pointed out the connection between the cultivation of monocultures and the consumption of fewer species, varieties and breeds.

This overview of the connection between conventional agriculture and food insecurity would be incomplete if it did not also address an irony related to the plight of many small-scale conventional farmers. A WHO Fact Sheet for 2016 revealed that worldwide, there were more than 1.9 billion overweight adults, with over 650 million of these termed obese. In 2017, the FAO, IFAD, UNICEF, WFP and WHO reported that 815 million people around the world were estimated to have been "chronically undernourished" in 2016. An FAO, IFAD and WFP report from 2014 stated that of the roughly 1.2 billion people living in extreme poverty, more than 75% live in rural areas, that a large portion are food insecure subsistence farmers, and that these small-scale farmers in Africa and Asia produce most of the world's food. "Poorer farm households," according to Quan (2011), "are more exposed to food insecurity because a shortage of cash and inadequate storage facilities compel them to sell much of their produce soon after harvest, often at low prices." It is an abhorrent irony that so many people who produce food for the rest of the world, are poor and food insecure.

Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. University of California, Davis

2. Sustainable Agriculture and Food Security: Government, Academia, and Private Sector Roles

2.1 Sustainable Agriculture - Definition, Principles

Table 1 lays out the definitions and descriptions of three major organizations in the sustainable agriculture world, namely the FAO (2014b), University of California, Davis' SAREP (n.d.), and the USDA's Western SARE (n.d.).

Table 1. Definitions and descriptions of sustainable agriculture from the FAO, SAREP, and SARE

Institution	Definition / Description
FAO	The management and conservation of the natural resource base, and the orientation of technological change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations. Sustainable agriculture conserves land, water, and plant and animal genetic resources, and is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.
SAREP	Sustainable agriculture integrates three main goals — environmental health, economic profitability, and social and economic equity.
SARE	Economically Viable: If it is not profitable, it is not sustainable. Socially Supportive: The quality of life of farmers, farm families and farm communities is important. Ecologically Sound: We must preserve the resource base that sustains us all.

Source: FAO (2014b); SAREP (n.d.); SARE (n.d.)

Among common themes worth highlighting, the most basic is inherent in the word sustainable, as it emphasizes that agricultural systems must be viable over the long term, though almost nobody says how long. For agriculture to be viable over the long term, it must obviously meet human needs as well as preserve the natural environment upon which it depends. Though all three organizations distinguish economic and social dimensions, this author considers economic issues to be contained in the social dimension, because economics exists only within human societies. Furthermore, because human societies exist only in, and depend on, the so-called natural world, it is logically sound (though perhaps impractical) to include the social dimension in the environmental dimension. A noteworthy addition comes from SAREP: "A systems perspective is essential to understanding sustainability … [because it] gives us the tools to explore the interconnections between farming and other aspects of our environment." To sum up, the definition of sustainable agriculture could be summarized as agriculture that satisfies shared human needs indefinitely, and at least preserves the ecosystem.

Even a definition as detailed as the FAO's requires elaboration for everyone involved to be able to collaborate in manifesting agricultural systems that are sustainable. Their five principles are laid out in Table 2 (with examples of key practices) (FAO, 2014b) and illustrated in Figure 1.

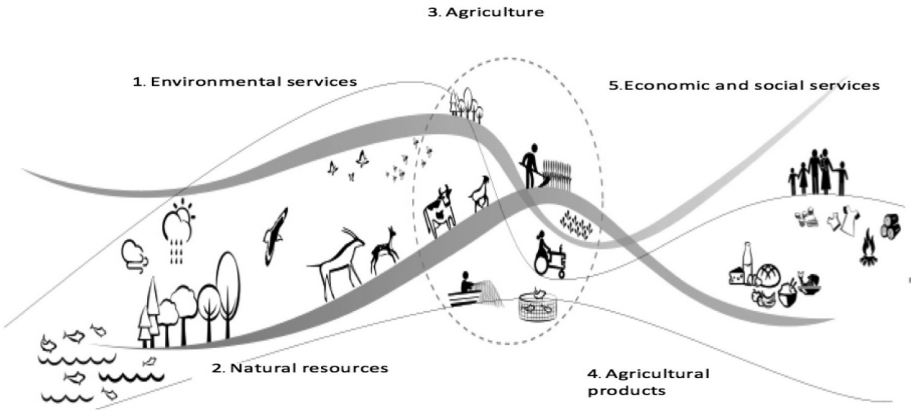
Table 2. FAO's 5 Principles of Sustainable Agriculture.

Principles	Examples of key practices
1. It improves efficiency in the use of resources, e.g. water, energy, agricultural inputs.	• improve soil moisture management • use IPM
2. It requires direct action to conserve, protect and enhance natural resources	• prevent water pollution by managing livestock waste • rebuild depleted fisheries stocks.
3. It protects and improves rural livelihoods and social well-being.	• increase rural jobs • improve rural nutrition

4. It enhances the resilience of people, communities and ecosystems against extreme weather, volatile markets, and civil unrest.	• prepare for and adapt to climate changes • encourage flexibility in production systems
5. It requires responsible and effective governance mechanisms.	• increase the "frequency and content of consultations among shareholders" • decentralise control

Source: Building a common vision for sustainable food and agriculture. (FAO, 2014b).

Conceptual model underpinning the vision



1. Environmental services: Climate, Nutrient cycling, Biodiversity, Water cycles, Coastal protection
2. Natural resources: Land, Oceans, Water, Genetic resources, Forest resources, Aquatic systems Nutrients, Energy
3. Agriculture: Crops, Livestock, Forestry, Fisheries, Aquaculture
4. Agricultural products: Food, Feed, Fiber, Fuel
5. Economic and social services: Growth, Poverty reduction, Employment, Stability, Health and nutrition

Figure 1. Reproduced from Building a common vision for sustainable food and agriculture (FAO, 2014b).

The logical next step is to define sustainable agricultural systems in more detail. To this end, a report from the UN's Sustainable Development in the 21st Century (SD21) project (2012) and Smith's et al. (2017) systematic literature review on sustainable intensification will be used to focus on agroecology, which has advocates in science and the FAO, permaculture, which is largely ignored by researchers but has a popular appeal, and New Theory farming, which has a large number of adherents in Thailand. These were chosen for their comprehensive views on sustainability.

2.2 Sustainable Intensification: Agroecology vs Permaculture

The SD21 project consisted of a panel of more than 60 people from 23 countries, considered to be 'thought leaders' in a wide range of agriculture and related fields, who formed four groups to discuss in detail a comprehensive array of aspects related to current and ideal agri-food systems (Giovannucci et al., 2012). Table 3 shows the nine areas where the experts were in complete agreement.

Among the nine, focusing on better nutrition and not simply more production; rehabilitating degraded land rather than opening up new land; encouraging businesses to purchase eco-friendly and fair-trade products, and otherwise conduct business to benefit the public; and reducing the amount of food wasted at every step of the agri-food chain, are among the many noteworthy visions for the future of food and agriculture.

Table 3. Areas of consensus of the panel of experts on current and ideal agri-food systems

Areas of consensus	Details
Invest in organized small and medium farms, fully including women	• because small and medium-sized farms are crucial for global food security • because women are important in agriculture and household food security • companies must be incentivized to direct their investments toward the greater public benefit
Focus on better nutrition, not simply more production	• policies and investments should focus on healthy food and people's access to it • eliminate subsidies for foods that are associated with diseases
Encourage eco-friendly agriculture	• 'productivity' must account for ecosystem services, e.g. carbon sequestration and biodiversity conservation • focus on various measures to increase on-farm water efficiency • rehabilitating degraded land rather than encroaching on wildlife habitat preserves biodiversity • agriculture will need to adapt to, and contribute less to, climate change • policies and markets must foster more eco-friendly agriculture
Encourage innovation and sharing technology	• encourage innovative-minded people to create new technologies that at once improve yields and are eco-friendly • encourage cross-border sharing of new and existing technologies

Reduce food waste all along the food chain	• it is relatively easy to reduce waste and increase the amount of food available, and reap benefits environmental benefits
De-emphasize biofuels; explore local production	• large-scale biofuel (e.g. from corn) production reduces the availability of these crops as food, and increases their cost
Collect accurate data	• having accurate data regarding many facets of food and agriculture will facilitate beneficial policies and investments
Develop and adapt public & private institutions	• especially government must restore natural resources so as to increase yields and enhance resilience to climate changes
Incentivize investments and business systems that benefit the public standards in agriculture, e.g. organic standards, best practices	• encourage commercial and production • businesses buying from sustainable sources, e.g. Starbucks • increase access of small and medium-sized farmers to credit

Source: Giovannucci et al. (2012).

Smith et al. (2017) conducted a systematic review of 104 publications to describe and evaluate sustainable intensification using the "themes of productivity, economic, environmental and social sustainability, and human wellbeing in both crop and livestock systems." They listed a broad set of indicators and metrics of sustainability taken from the literature, then put them into 5 domains. Table 4 shows the indicators (along with example metrics) that they found to be the most common.

Table 4. Domains and example indicators of sustainable intensification.

Domains	Example indicators
Productivity	biological inputs, crop diversity, input efficiency, resilience, yield
Economic sustainability	agricultural income, crop value, access to inputs, labor productivity
Human well-being	food safety & security, nutrition, quality of life
Environmental sustainability	biodiversity, carbon sequestration, ecosystem services, environmental impact, erosion, GHG emissions, healthy soil
Social sustainability	access to information, gender equity, social connectivity

Source: Smith et al. (2017).

Both agroecology and permaculture encompass holistic agricultural systems, which are similar in scope and effects on the various dimensions of sustainability. They are examined briefly through the lenses of Giovannucci's et al. (2012) areas of consensus regarding what sustainable agricultural systems need to entail, then Smith's et al. (2017) domains of sustainability.

A professor of agroecology at UC Berkeley writes that "Agroecology is the holistic study of agroecosystems including all environmental and human elements," or more specifically, it "provides basic ecological principles for how to study, design and manage agroecosystems that are both productive and conserve natural resources, while remaining culturally sensitive, socially judged and economically viable" (Altieri, 1995). It is sustainable in the areas of better nutrition, eco-friendly agriculture (e.g. ecosystem services, carbon sequestration, biodiversity conservation, reduced green-

house gas emissions, less water use and increased water retention in the soil, rehabilitating degraded soil, and contributes less to climate change), innovating and sharing, and collecting accurate data, Altieri et al., 2012; De Schutter, 2010). These same authors also report many examples of agroecology farms satisfying all the domains of sustainability in Smith et al. report.

Permaculture is sustainable in the same areas as agroecology except that scientific data is scant (Conrad, 2014; Ferguson & Lovell, 2013), in part because, in the words of one permaculturist, some of the best practitioners are "too busy implementing" and not documenting (B. Pritchard, personal communication, May 23, 2018). Permaculture is more of a grassroots movement than an agricultural movement than is agroecology, though both were originally promulgated by academics. Its origins began with the concept of "permanent agriculture" (hence the name), meaning "integrated, evolving system of perennial or self-perpetuating plant and animal species useful to man". This eventually broadened into "permanent (sustainable) culture" in which "the use of systems thinking and design principles [provides] the organising framework for implementing" sustainable culture (Holmgren, 2015).

Agroecology's strongest presence as an agricultural science and socio-political movement is in Latin America, where it is more common than in Asia. It has a strong presence especially among peasant farmers and activists. Permaculture, on the other hand, is most popular in North America, Europe, and Australia (where it originated) among Caucasians, though has a fairly strong presence in all regions of the world. Both emphasize comprehensive outlooks on human life that integrate environment, society, and economics, as well as holistic design as a basis for harmonious landscapes. The sustainability of these systems depends in part on the philosophies and the guiding principles, as well as the practitioners' application of the philosophies and principles.

Following is a brief look at these principles and philosophies found in the two systems. Paraphrasing a publication on the basics of agroecology, many of the principles may be summarized thus: optimising organic matter decomposition and nutrient cycling, fostering functional biodiversity of species and genetic resources within the ecosystem over time and space

so plants and farm animals are stronger and better able to resist disease and pests, and in the socio-economic dimension by creating and recognising the value of diverse collective knowledge and know-how (Third World Network & SOCLA, 2015). Permaculture's 3 ethics - care for earth, care for people, and take only your fair share - serve as a framework for the various principles. The 2 most common sets of principles, created separately by the co-founders, include: making each element in a design perform many functions and making each important function supported by many elements (Mollison, 2000) and observe and interact, catch and store energy, and design from patterns to details (Holmgren, 2015). Permaculture pays particular attention to patterns in the design of human landscapes, not only agricultural landscapes. Its orientation towards design means it is equally applicable to a garden or a farm as it is to structures such as homes and businesses, thus permaculture principles have a limitless potential for application. Both alternatives to industrial agriculture are potentially sustainable. It depends on how well the principles and philosophies / ethics are adhered to.

2.3 Roles of Education and Relevant Institutions

How can researchers, in consort with governments and the private sector, support sustainable agricultural development? Wals (2015) provided some overarching ideas on education reform, arguing for educational systems that equip students with abilities (see p. 39 for more on what he calls "sustain-abilities") to deal with complex and confusing situations; learner-centred, self-regulated learning; more emphasis on practical situations and problem-solving; as well as government facilitation of this sort of education. He challenged educational institutions to "mimic the kind of sustainable practices they seek to promote," i.e. practice what they preach (which could apply equally to government and the private sector, insofar as they teach sustainability to others), and he insisted that the economy should be a means, not an end. Figure 2, below, represents the possibility when people cooperate to create sustainability.

To elaborate on some of his ideas, educational institutions need to become able to offer an interdisciplinary approach to preparing students to be able to apply systems thinking skills for solving problems such as food and nutrition security, but that education systems are currently unable to because they are still based on a reductionist world view. He remarked

that "the more educated we become the better we get at thinking the world into pieces and seeing the parts but losing the ability to see relationships, interdependencies and wholes." In addition to an integrated approach to education, the institutions providing education and research should also be a place where one can learn of innovations, have access to experts who can help with problem-solving, as well as a place where one can learn and develop new skills. The role of governments are not overlooked, in that they ought to stimulate and support this "hybrid teaching environment" where there is little distinction between science and society, school and neighborhood, and local and global, all of which are consistent with permaculture's first two ethics: people care and earth care.

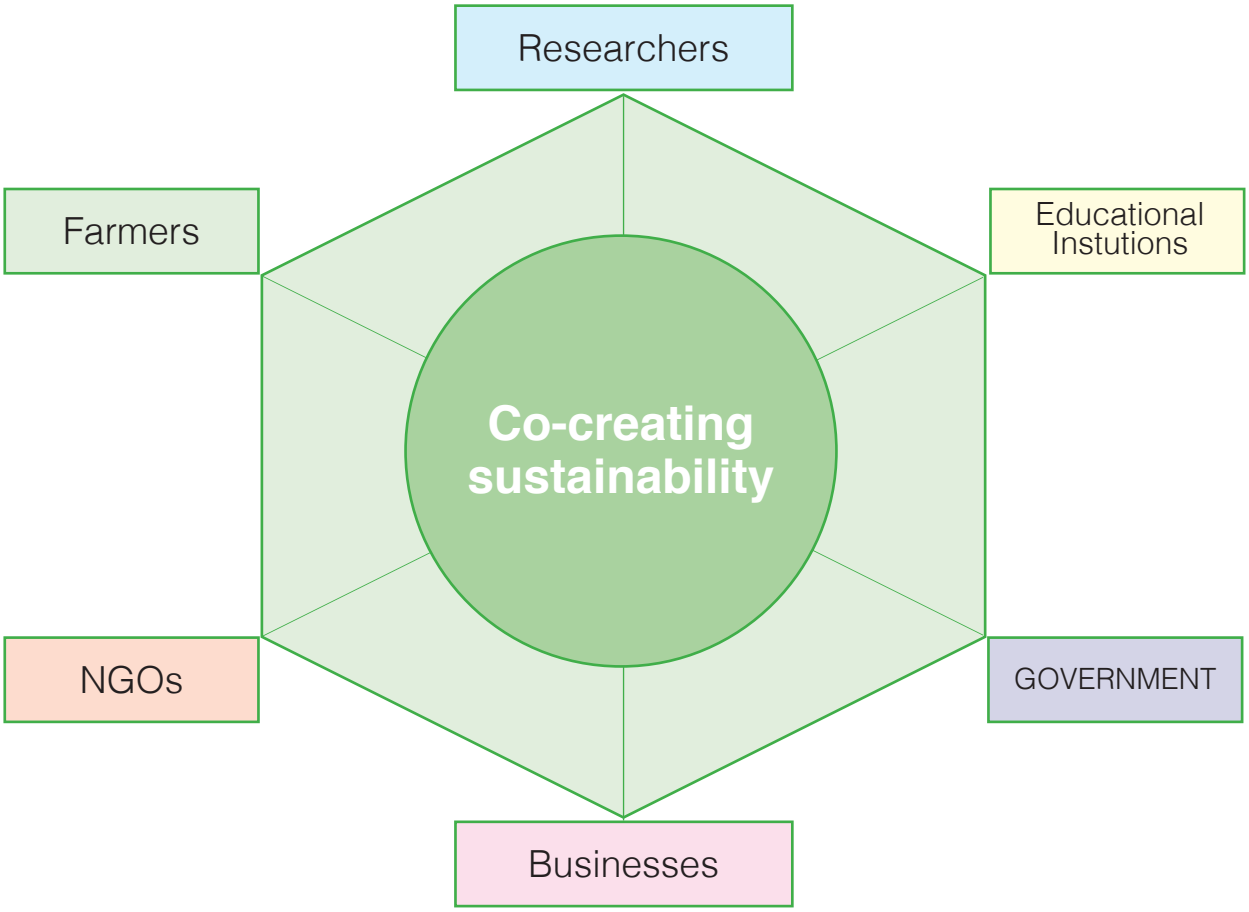


Figure 2. The stakeholders contributing to sustainable agriculture.
Source: Adapted from Wals (2015).

From Wals' overarching ideas, we turn to Quan's (2011) discussion of important ways for government, research institutions, and the private sector to support small-scale farming in the near to mid-term future. He identified four "inter-related challenges," namely, improvements in small farms' productivity, environmental sustainability and resilience, connection to markets, and human and organisational capacity. He calls for increasing the effectiveness of agricultural extension and related services, improving financial and marketing services, increasing the fairness and balance regarding agricultural biodiversity and appropriate seed supply systems, and reforming government policies that affect small farm development. Some of his specific recommendations for these three sectors of society within the four inter-related challenges are as follows:

2.3.1 Extension and Related Services

Because the private sector stands to gain little to nothing by investing in small farmers, they tend to not invest in small farmers, thus governments and NGOs must continue to support them, with increased attention given to women farmers. The nature of extension services should become more flexible and "client-oriented", emphasising participation of farmers in every aspect of their work and lives. Better coordination and effectiveness among public and private organisations and NGOs that deliver extension and advice are needed.

2.3.2 Market Development and Access to Financial and Business Services

Trade and distribution channels should be diversified, and the viability of local, wholesale, and export markets should be ensured (in part by improving infrastructure) to create a wider range of options for farmers. Access to credit should increase, innovations in micro-financing and rural banking should continue, and the use of mobile phones and other ICT to provide marketing and financial services should expand. Policies that encourage and facilitate small farmers' organisations should be established.

2.3.3 Agricultural Biodiversity and Seed Systems

There should be increased cooperation between formal researchers and farmers to breed plants for selection of varieties that meet farmers' needs. Farmers should get training on how to select, store, and manage plant materials (e.g. open-pollinated seeds, cuttings, etc.).

2.3.4 Access to Land

These recommendations are specifically for governments to follow the lead of those countries that 1) currently give legal and constitutional recognition to traditional land rights systems 2) create and adapt policies that work harmoniously with traditional systems of land rights systems, and 3) use modern technologies to establish and verify property borders

2.4 Food Security

Because any serious discussion should begin with a clear understanding of important terms, this section will define food security according to the FAO, in conjunction with sustainable agriculture. Discussion of how governments, academics, and businesses can support farmers will be elaborated on.

Signatory countries at the World Food Summit in Rome, in 1996, declared that food security exists when "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2014a). Signatories to the declaration committed to reduce the number of food insecure people in the world from more than 900 million to less than 400 million by 2015. There were still about 815 million, in 2016 (FAO, 2017).

3. Overview of Agriculture in Thailand; Roles of Small and Large Farms; Impacts of Educational Institutes on Agricultural Sustainability

Agriculture has played a key role in Thailand, contributing to its economic growth and food security. In 2014, nearly a half of the country's land (46.53%) was used for agriculture, with 24.76 million people (38.02% of total population) engaged in this sector (MOAC, 2016). Since the 1960s, Thai government policies have gradually pushed agriculture toward 'export-oriented, commercial agriculture' with such policy instruments as promotion of high-yielding crop varieties and chemical inputs (Kasem & Thapa, 2012). This has led to various negative effects in the following decades including natural resource degradation, 'agrochemical dependency' and farmers' health problems (Kasem & Thapa, 2012; Nelles & Visetnoi, 2016).

ศูนย์เรียนรู้ แปลงสาธิตการปรับเปลี่ยน
สูระบบเกษตรอินทรีย์
ที่ตั้ง บ้านปีก หมู่ที่ 4 ตำบลท่าข้าม
เจ้าของแหล่งเรียนรู้ นางจีรวรรณ ทะสะระ

However, the turn was made during the 1990s with government policies aiming to develop sustainable agriculture, including promotion of crop diversification, organic agriculture and healthy food, and discouragement of inorganic fertilizer and pesticide use (Kasem & Thapa, 2012). Over the years, various actions have been taken to realize sustainable agricultural development. For example, promotion of organic product markets, provision of 'green credit' for safe food production, and promotion of Good Agricultural Practice (GAP) (Kasem & Thapa, 2012; Kampa, 2017).

The following will focus on the state of Thailand's agricultural sector, emphasizing data from the country's 12th 5-year national economic and social development plan, which took effect in 2017. The plan calls for a shift away from monocultures, towards various styles of sustainable agriculture, with 5 million rai under sustainable cultivation by 2021. It is remarkable for being brutally honest in its assessment of the internal situation and trends. Positive points regarding agriculture's current state include government encouragement of farmers to form cooperatives, partnerships and companies, and the 2014 export of rice ranked 2nd, and rubber 1st, in the world.

The negative points are far more numerous and impactful. Conventional farmers, especially those practicing monoculture, have seriously polluted natural ecosystems with chemical inputs; destroyed the soil; exhibited poor water management, which could lead to water shortages; reduced forest area by about 2 million rai per year from 2008 to 2013; and have comparatively low productivity (for example, rice yields 459 kg per rai, lower than Vietnam, Myanmar, and Lao, with 836, 654 and 576 kg, respectively). Farmers have not dealt with climate change, which has created more frequent and extreme natural disasters, which in turn affect farm harvests, and compounds the problem of poverty. (Due to Thailand being the world's #2 rice exporter, this also affects world food security.) The Plan states that "the environment has degenerated in all aspects," including marine ecosystems.

Since 1987, the economic base has shifted away from agriculture towards the manufacturing and service sectors, and has been developing more slowly. The population working in the sector declined dramatically from 64.0% in 1990 to 31.6% in 2015. Structural reforms to enhance agri-

cultural efficiency and value-adds have been delayed. Export volumes are on the decline, and there has been increased competition from China, Cambodia, Lao, Myanmar, and Vietnam. Very high subsidies are a heavy budget burden, and do not contribute to the sector's productivity. Farming income is much lower than in the manufacturing and service sectors. This stark income inequality and lack of fairness in many other aspects (e.g. allocation of land and other natural resources), have fomented disharmony in society.

Turning now to FAO statistics, the situation vis a vis food security is improving over the long term. Between 1990 and 2014 the proportion of undernourished dropped by 80.9% from 35.7% to 6.8% (FAO, 2014a), then in 2014 – 2016 climbed to 9.5%, with no "severe food insecure" (FAO, 2017). Most of the food insecure are poor rural farmers (Leturque & Wiggins, 2011), whose farms may be considered small by the data in Thailand's 2013 agricultural census. A smallholder farm is on average less than 10 rai (equivalent to 1.6 hectare), consistent with a definition that Lowder et al. (2016) state is commonly accepted.

The census gave a breakdown by size of the nation's 5.9 million farms:

- 23.3% were under 6 rai (under 0.96 ha)
- 13.8% were 6 to 9 rai (0.96 to 1.44 ha)
- 50.7% were from 10 to 39 rai (1.6 to 6.24 ha)
- 11.7% were from 40 to 139 rai (6.4 to 22.24 ha)
- 0.5% were 140 rai and over (22.4 ha and over)

It separated farms into five sizes, without assigning a size name, so here they are called *very small, small, medium, large,* and *very large.*

Following is a brief look at the roles of small and large farms with respect to sustainability. More than a third of Thai farms are small farms, mostly in rural areas, where the majority of poverty exists (NESDB, 2013), where small-scale farming is a pillar of traditional society. Jitsanguan (2001) remarked that they contribute much to "food security, environmental conservation and the solidity and self-reliance of rural communities" and "social capital," i.e. traditional farming knowledge and wisdom, which are all crucial for sustainable agriculture in the broadest sense. She also claimed that small-scale farmers do not "contribute very much in terms of market value".

It appears that this is still true. According to the census, 37.1% of Thai farms are smaller than 10 rai. A 2018 report issued by the Thai Office of Agricultural Economics (OAE) showed the agricultural sector's contribution to the country's GDP for 2017 was just under 1.34 trillion baht, or 8.66%. Using the census figures for very small and small farms, this works out to 496.1 million baht, or only 3.2% of the country's GDP. Thailand has 31.6% of the workforce in agriculture, and a little over a third of them run small farms, yet account for only 3.2% of the country's GDP. It appears that they still make a small contribution to the "market value".

Insofar as industrial agriculture is Green Revolution agriculture, the record is clear that there have been positive things to say, yet that it is past time to move quickly to sustainable agriculture. Positive aspects of large-scale farms include the ability to produce large amounts of food at low labor costs, which, in an age of a declining agricultural labor force, is desirable. Thus, they can more easily supply enough food to meet export standards and local supermarket standards than small producers (Dawe, 2015). Yet, despite increased practice of and interest in organic farming, sustainable agriculture of any kind is practiced by only a tiny fraction of farmers (Panyakul & Kongsom, 2015).

The 2013 census shows that the total area of the largest farms (at least 40 rai) accounted for 12.2% of all farm holdings, which is a substantial portion of the total 116.6 million rai. Whether or not large farms are more efficient than small farms has been debated among researchers since the advent of the Green Revolution, when researchers started to examine the efficiency of larger farms. Before that, small farms were regarded as more efficient largely because of lower overhead due to not having to hire outside labor. Research on the efficiency of large-scale farms has revealed various factors showing them to be more efficient. Shenggen and Chan-Kang (2005) conclude that "differences in the intensity of land use, land fertility, and managerial factors" appear to bear on farm efficiency, while Barret et al. (2010) argue that such research results are anomalies. Using the Thai OAE's report mentioned above and the agricultural census data, we can determine how much large farms contribute to the country's GDP. Large and very large farms, i.e. those that are at least 40 rai, made up 11.2% of the 1.34 trillion baht generated by farmers, for 149.8 million baht, or 0.97% of the country's GDP, smaller than the contribution of small farmers.

Five types of agriculture are considered sustainable in Thailand. Kampa (2015) stated that they were 1) integrated farming - a 'farming system that has at least two different agricultural activities in the same field' 2) organic farming - a 'farming system that uses only organic fertilizer and herb-based insect-control compound' 3) natural farming - a farming system with 'no tillage, no application of fertilizer, herbicide and insecticide' 4) agroforestry – which is 'an idea to put agriculture and afforestation together, that is, to plant cash crops or raise livestock while planting trees in the same area', and 5) New Theory farming with 'self-sufficiency' as its foundation.

Based on a review by the Thai Agriculture, Natural Resource and Environment Planning Office (2011), a brief overview of the five sustainable agricultural practices can be summed up as follows: integrated farming helps to address risks associated with monoculture, dependency on production inputs, and non-use of agricultural residuals. With land as the main resource, integrated farming is aimed at income security and economy of scale, and maximizing on-farm resources. Organic farming is practiced to rehabilitate the soil after degradation from conventional agriculture, including chemical residuals from agricultural products. With soil as the main resource, organic farming is aimed at restoring soil fertility and food safety. The ecosystem is considered the main resource in natural farming, and is aimed at balancing the ecosystem after its destruction from conventional agriculture. This farming system also helps to reduce dependency on production inputs. Agroforestry is aimed at an increase of forest areas in the country, co-existence between forest and agriculture, and biodiversity. With forests as the main resource, agroforestry is practiced to protect forest areas from encroachment. New Theory farming helps to address the risk of drought and water shortage, and farmers' food insecurity. As such, water is the main resource for this farming practice with its focus on income generation, food security, and water resource management.

According to Kampa (2017), in 2016, there were 484,633.44 ha in total with sustainable agriculture practices based on the preliminary report by Department of Agricultural Extension (Table 5). The 12th National Social and Economic Development Plan (2017-2021) aims to increase the areas to 800,000 ha by 2021 (NSEDB, 2016).

Table 5. Agricultural areas with sustainable agricultural practices

Type of agricultural practices	Agricultural areas (ha)
Integrated farming	91,013.76
Organic farming (areas with certification)	25,630.24
Agroforestry	4,644.48
Natural farming	349,755.20
New Theory farming	13,589.76
Total	484,633.44

Source: Kumpa (2017)

As mentioned above, one agricultural practice recognized as 'sustainable' in Thailand is New Theory farming, founded on Sufficiency Economy Philosophy (SEP). The following sections discuss SEP and New Theory farming in detail. Examples of SEP, agroecology, permaculture and New Theory farming are provided.

Examination of New Theory farming vis a vis the areas of consensus regarding conditions of sustainability as laid out in Giovannucci (2012), (see Table 3 page 7), and the domains of sustainable intensification as laid out by Smith et al. (2017), (see Table 4, page 8), provides details on the sustainability of New Theory farming.

Consensus areas, (Giovannucci et al., 2012)	**How New Theory farming coincides**
• Invest in organized small and medium farms	• the focus is squarely on small farmers
• Focus on better nutrition, not simply more production	• emphasis is on feeding oneself and family first, fresh and plentiful organic food is ensured
• Encourage eco-friendly agriculture	• organic is strongly encouraged
• Encourage innovation and sharing technology	• especially at step 2 of the implementation process, sharing is facilitated
• Develop and adapt public & private	• this also is consistent with step 2 of the institutions implementation process
• Reduce food waste all along the food chain	• the general thrust of Sufficiency Economy discourages waste

Nearly all of the indicators in Smith's et al. (2017) domains of productivity, human well-being, and economic, environmental, and social sustainability, are inherent in New Theory farming. Namely, the emphasis on biological inputs, crop diversity, agricultural income, nutrition and quality of life, and healthy soil are all integrated within the farming system. Among the only indicators absent is any attention paid to gender equity.

3.1 Agroforestry in Thailand

Agroforestry is considered by adherents of both agroecology and permaculture to be within their realms, and due to the similarities of both, agroforestry does coincide with the principles of each. In Thailand, aside from agroforestry, there seems to be little or no presence of agroecology, and permaculture is hardly known.

Rubber-based agroforestry is the most common type of agroforestry in Thailand, and is concentrated in the south, the region growing the most rubber. Research comparing rubber-based agroforestry and rubber monoculture in 3 provinces of southern Thailand shows agroforestry superior to monoculture for the environment, for the household economy, for society, and for the individuals involved (Kittithurakul et al., 2014). As indicators of greater environmental sustainability, they reported more complexity in the tree layer canopies, which leads to more leaf litter, thus protecting the topsoil from erosion due to wind and rain, and better water retention in the soil; more stable soil moisture and soil temperature, which foster soil microorganisms and macroorganisms so they break down the leaf litter at a greater volume and speed; and more biodiversity of plants and animals. For the household economy, agroforesters have access to a greater diversity of products to consume and sell throughout the year, which reduces expenses and increases earnings now and in the future (by selling trees when they reach maturity); save money by spending less on fertilizers due to the greater nutrient recycling; yield more rubber latex without additional expenses; and 4 of the 6 agroforesters used their farms as learning centers, through which they gained income from conducting formal training. Society at large (all ages and all sectors of society) benefited by attending trainings on agroforestry. The authors reported that visitors also expressed pleasure when spending time in the forests. Individual farmers and their families reduced their dependence on market produce, which positively affected their health, and the simple joy of being on the farm had a positive influence on the farmers' state of mind.

Sugiyama (2017) wrote a master's thesis on coffee-based agroforestry that shows signs of sustainability in Chiang Rai Province of northern Thailand. Her research used *Sustainable Livelihood Framework (SLF)* to illustrate how the lives of hill tribe villagers have changed for the better socially as well as economically, though she did not clearly state that the health of the forest ecosystem is improving, and did not examine productivity (which is one of Smith's et al. criteria). This thesis is admittedly not the ideal source to argue that agroforestry is a system of agriculture that meets the criteria laid out by Giovannucci et al. (2012) and Smith et al. (2017), but provides enough evidence to justify its inclusion here. The data from the thesis is grouped below into a social dimension (including Smith's et al. human well-being category), an economic dimension and an environmental dimension.

In the social dimension, she mentioned that the coffee farmers are generally satisfied with their lives and have more self-confidence and pride in their identities as coffee farmers and forest guardians. The farmers are self-employed and have their own land to cultivate, with at least one farmer having several hundred rai of land. Increased incomes – up to 7 times their previous incomes – from coffee bean sales, as well as produce from their homegardens and the chickens they raised, led to more food security than before they started growing coffee. Contributing to their food security are wild edible plants, mushrooms, and medicinal herbs from the forest, in addition to the rice and vegetables that some villagers still grow. Due to the increased incomes, many farmers can afford to send their children to school, which was not the case in recent decades. These villages are remote, and access is still difficult, but with involvement in the markets for coffee and other crops, roads to and from the villages have been improved greatly. This brings greater opportunity for various kinds of contact with the outside world, including tourists. She pointed out that there are risks involved to the social sustainability of the village, such as from illegal drug smuggling and selling. As mentioned by one research participant, more access to mainstream society has led to erosion of traditional values and customs.

In the economic dimension, the farmers grow and sell other crops in addition to coffee, such as tea, rice, macadamia nuts, avocadoes, apricots, peaches, plums, pears, and bananas. Some raise pigs which are usually sold and consumed within the villages. The participants in the study stated that it is usually difficult to borrow money from banks, but intra-communal credit schemes are available within some of the five villages studied. Some farmers do off-farm work, contributing to income diversification, which is a sound economic strategy that applies equally to farms as it does to other aspects of life. So-called industrial farming is perhaps one of the few areas of society where diversification is discouraged, i.e. monocropping is encouraged. Market volatility of the 1980s was discussed, when many of these villagers had been growing coffee under the Royal Project, but stopped because of low demand. It bears noting that when demand drops again, as it most certainly will, a portion of these farmers will very likely quit, and may return to unsustainable ways of farming. Therefore, growing trendy crops, such as shade-grown agroforestry coffee as the major component of a farmer's strategy, may someday be considered unsustainable.

In the environmental dimension, though she offered no direct evidence of the health of the forest, she mentioned that SLF indeed includes an environmental component, and discussed issues that suggest improved forest health. For example, though 'slash and burn agriculture' was common until the government began promoting agroforestry under the Royal Project in the 1980s, it has been replaced by techniques that conserve natural resources such as interplanting, which is common in agroforestry. They use manure from the pigs for their crops, while a few make their own compost, thus reducing or eliminating their dependence on off-farm inputs. Also, some of the farms have been certified as organic, though not many.

Though permaculture's presence in Thailand is weak, it has been embraced by Western expats, and a few Thais. There are several locations throughout the country teaching it, more in the north than in other regions. Regrettably, most of them focus more on teaching permaculture than on applying its principles. There seem to be no dedicated gardens or farms, designed and run according to the ethics and principles. The great majority of Thai farmers have probably never heard of permaculture, and only two books in Thai language have been published about it, one of which is long out of print. As noted above, income diversification is a sound economic strategy, unless more people practice permaculture on a commercial scale, it is unlikely to ever take hold in Thailand. Some argue that permaculture is not scalable, though there are examples of large permaculture farms that produce large harvests. Perhaps most pertinent to Thailand, is Zaytuna Farms, in a semi-tropical part of Australia, thus the climate shares some similarities with Thailand's. Though there are no statistics comparing its productivity or efficiency, it is among the most respected permaculture site in the world.

The person most often credited with the founding of permaculture, Bill Mollison, though a trained and experienced scientist and naturalist, established a reputation for the design system by teaching it through 2-week courses to anyone who was interested, without seeking out farmers specifically. Its ethics and principles, as well as the techniques that many people associate with permaculture, are still taught through these courses; in Thailand, the courses are generally attended by Western, middle-class Caucasians. In their home countries, many serious farmers see permaculture as dominated by hippies and new age followers. This image could very

well be an obstacle to its acceptance by the academic community. In 2013, Ferguson and Lovell, published a review of the literature on permaculture, claiming that the majority of it is written by non-scientists, for a popular audience, and that despite strong similarities, "[s]ubstantive assessment of permaculture as an approach to agriculture, positive and negative, appears to be absent from the peer-reviewed literature." They contend that the very real potential of permaculture to aid the transition from conventional to agroecological agriculture, this isolation from the research community is a hindrance.

3.2 Sufficiency Economy Philosophy (SEP) and its Relevance to Sustainable Agriculture

3.2.1 History and Definition of Sufficiency Economy Philosophy

Sufficiency Economy is a philosophy that King Rama IX, Bhumibol Adulyadej, bestowed upon the people of Thailand through royal remarks on many occasions over the past four decades, since 1974. Our beloved King has provided guidance on appropriate conduct covering numerous aspects of life. A framework was offered through "Sufficiency Economy Philosophy" by King Rama IX in remarks made in December 1997 and 1998 when Thais suffered from economic crises. The philosophy points the way for a recovery that will lead to a more resilient and sustainable economy that is better able to meet emerging challenges brought about by globalization (NESDB, 2007).

In 1999, a working definition compiled from remarks made by His Majesty the King on various occasions was approved by His Majesty and sent by His Majesty's Principal Private Secretary to NESDB. Unofficial translation of the definition is provided in Box 1.

Based on the official definition of the Philosophy (Box 1), in 2001, the Sufficiency Economy Working Group (SEWG) was informally set up jointly between the NESDB and the Crown Property Bureau mainly in order to further interpret and elaborate on the philosophy of Sufficiency Economy. They worked on developing an economic framework and applying it to the development process in Thailand as well as widening its application in daily life and various activities at all levels of society as stated in the official definition (NESDB, 2004).

Based on the official definition of the philosophy presented in Box 1, the SEWG conducted the work via a deductive process 'parsing' the definition into syntactically and semantically analyzed components. The working group concluded from the following exposition of the term Sufficiency Economy regarding 1) Form and Function (Box 2), 2) relevant contexts (Box 2) and 3) the working definition (Box 4).

Box 1: Sufficiency Economy Philosophy

"Sufficiency Economy" is a philosophy that stresses the middle path as an overriding principle for appropriate conduct by the populace at all levels. This applies to conduct starting from the level of the families, communities, as well as the level of national development and administration so as to accommodate change in line with globalization.

"Sufficiency" means moderation, causal relationship, and the need of self-immunity or resilience for sufficient protection from impact arising from internal and external shocks. To achieve this, an application of knowledge with due consideration and prudence is essential. In particular, great care is needed in the utilization of theories and methodologies for planning and implementation in every step. At the same time, it is essential to strengthen the ethical integrity of the nation, so everyone, particularly public officials, academics, businessmen at all levels, adheres first and foremost to the principles of honesty and integrity. In addition, a way of life based on patience, perseverance, diligence, wisdom and prudence is indispensable to create balance and be able to cope appropriately with critical challenge arising from extensive and rapid socioeconomic, environmental and cultural changes in the world.

Source: NESDB (2004)

Box 2: Regarding the form and function of Sufficiency Economy:

(1) 'Sufficiency Economy' is a philosophy serves as 'guide for the way of living/behaving for people of all levels toward the middle path'.

(2) As an agenda, Sufficiency Economy delivers the middle path as the 'economic life guiding principle', i.e. a secularized normative prescription, but not a religious statement of faith.

(3) For application domain, Sufficiency Economy is scalable, with 'universal domain applicability': individual, household, community, project, business, management, institution, polity, society, nation state, region, humanity, and biosphere.

(4) As the foundation for an economic framework, Sufficiency Economy is complete, governing everything from motivation (utility, drives, etc.), to criteria (goals, objectives, etc.), to behavior (production, consumption, investment, etc.), to system (collectivity, connectivity, etc.), and can be said to, at least implicitly, address all issues within a dynamic setting.

Source: NESDB (2004)

Box 3: Sufficiency Economy regarding relevant contexts - Source: NESDB (2004)

(1) As the past course of development, Sufficiency Economy has been put forward for quite some times, and is not initiated as a result of the Asian Crisis.

(2) As the present course of development, however, in the post-crisis environment, it has been reemphasized as the solution to globalization and changes.

(3) As the future course of development, the middle path remains critically needed, particularly now with the process of pursuing economic and social development to keep pace with globalization.

(4) As the promise of future, Sufficiency Economy ensures balance and readiness to cope with fast/extensive changes with respect to materials, society, environment, and culture.

(5) As a paradigm shift, Sufficiency Economy arises against the backdrop of globalization driven integration of the world and the pace of technological-cultural-social changes.

Box 4: 'Sufficiency Economy' regarding the working definition

(1) 'Sufficiency' entails three components: moderation, reasonableness, and requirement for a self-immunity system, i.e. able to cope with shocks from internal and external changes.

(2) Two underlying conditions are necessary to achieve 'Sufficiency:'' knowledge and morality.

(3) For knowledge conditions, Sufficiency Economy requires breadth and thoroughness in planning, and carefulness in applying knowledge and in implementation of those plans.

(4) For moral/ethical criteria, Sufficiency Economy enforces the conditions that people are to possess honesty and integrity, while conducting their lives with perseverance, harmlessness and generosity.

Source: NESDB (2004)

3.2.2 Expanded Definition of Sufficiency Economy Philosophy

The official definition in Box 1 can be illustrated in Figure 3. From the official definition we find that there are three interlocking elements representing the three principles of SEP: 1) moderation, 2) reasonableness and 3) self-immunity. These three principles are interconnected and interdependent.

1) Moderation refers to the idea of people living their lives on the middle path. People live according to their own needs, within the realm of what they reasonably consider moderate.

2) Reasonableness is also needed to live on the middle path. Reasonableness can be defined as accumulated knowledge and experience, along with analytical capability, self-awareness, foresight, compassion and empathy. One must be aware of the consequences of one's actions for oneself and others.

3) Self-immunity is the ability of people to protect themselves against any crises, and cope with unexpected events that affect their lives. Self-immunity may need a foundation of both self-reliance and self-discipline.

In addition to the above three components, in order to make the principles of sufficiency economy work, two other conditions are needed. They are knowledge and morality. Knowledge encompasses wisdom, due consideration and great care so one can accumulate information with insight

to understand its meaning and apply to use (Puntasen, 2015). Morality is related to integrity, trustworthiness, honesty, ethical behavior, perseverance, and a work hard ethic (Mongsawad, 2010). Practicing the three principles with the two underlying conditions, living safely and harmoniously in a sustainable society and environment is possible. People would also be able to tolerate and cope with all manner of negative impacts arising from globalization (Mongsawad, 2010).

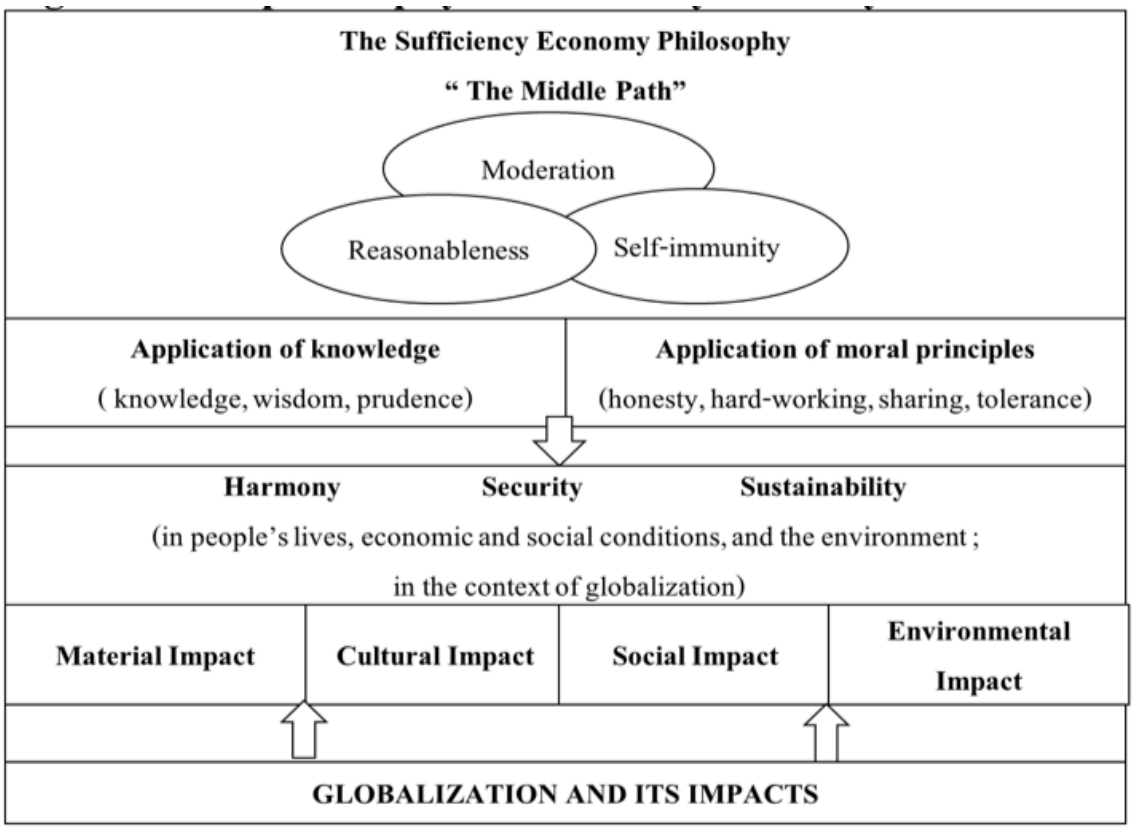


Figure 3: Sufficiency Economy Philosophy Framework
Source: Thongpakde (2005) Thailand's Economic Development and the Philosophy of Sufficiency Economy. Unpublished. Cited in Mongsawad, 2007.

3.2.3 Application of Sufficiency Economy for Farmers

The application of Sufficiency Economy Philosophy is New Theory farming. King Rama IX introduced this farming system, offering farmers the opportunity to employ and apply their wisdom and skills to support themselves in ways that are suited to their particular circumstances (NESDP, 2007).

The New Theory farming may be implemented in three steps:

The First Step is implementation at the individual and household levels. Individuals and households focus on managing agricultural land and resources in ways that provide enough return to live appropriately and with self-reliance, according to their unique circumstances.

The Second Step is a progressive step, starting after the individual or the household is able to satisfactorily meet their needs. They then form cooperatives to collaboratively produce goods, organize markets, and develop community welfare. This step is aimed at increasing social solidarity and preparing communities to deal with and interact with the outside world.

The Third Step is also progressive, and is intended to build contacts and partnerships with outside institutions. Collaboration can be made with other organizations and networks such as banks, businesses, governments and nongovernmental organizations. Financial, knowledge and technical support that are necessary for further development can be sought from outside organizations or communities.

A model of small farm management was developed by the King Rama IX to ensure food security and protect farmers from droughts and debts due to fluctuating prices (Ministry of Foreign Affairs, 2015). The model advises farmers to divide their plots into four sections, as follows: 30:30:30:10. Thirty percent is for a reservoir to ensure a continual water supply for farming. Another 30% is for rice fields, and a further 30% is for vegetables, field crops, fruit or timber trees, herbs, etc., and the remaining 10% is for residence and livestock areas. The appropriate size of land to ensure self-sufficiency may be about 10-15 rais (4-6 acres or 1.6-2.4 hectares) (Ministry of Foreign Affairs, 2015) (Figure 2).

New Theory farming is a kind of sustainable agriculture, as it promotes integrated farming, consisting of rice, trees, vegetables, and medicinal herbs (Mongsawad, 2010). Trees and plants can help to prevent soil erosion and provide natural fertility, as well as help to keep moisture in the soil. Farms run according to New Theory farming can help to improve the local ecology and even the global the environment. The product of the farm can be consumed in the household consumption, and sold in markets for household income. Therefore, such a farm enhances the well-being of the farm household, and to lesser extents, the community, the nation, and the world.

Success stories of farmers who employ New Theory farming and Sufficiency Economy Philosophy can be witnessed all over Thailand. Those farmers now have better lives and continue to conserve the environment (case shown in NESDB (2010) and the next section). The Sufficiency Economy Philosophy concept on environmental sustainability is applicable to both rural and urban areas. Following the three principles: moderation, reasonableness and self-immunity, as well as the two conditions: knowledge and morality, people, businesses and public organizations will strive for a healthier environment and a better quality of life.

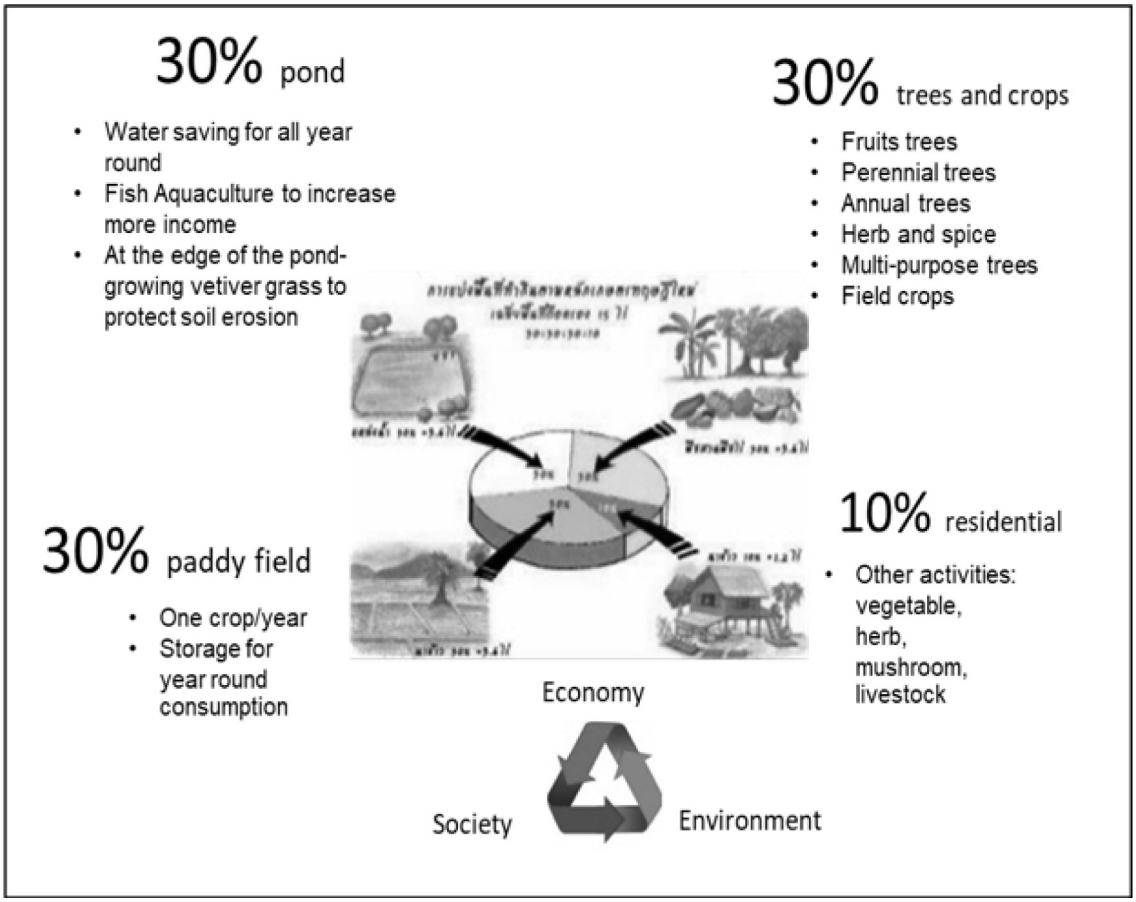


Figure 4: New Theory farming system in Thailand
Source: Rak Tamachat

3.3 Thailand's Best Practices and Lessons Learned in Agricultural Development

Applied to agricultural development, the Sufficiency Economy approach has evolved practical guidelines and best agricultural practices for sustainable agricultural management under New Theory farming for each of the three steps outlined above. The following cases are examples of these best practices and the successful projects created to demonstrate the Sufficiency Economy approach.

3.3.1 The Case of the Ban Daen Samakkhee Demonstration Project

The refined guidelines for a new theory for agriculture were first tested in the arid northeast at Ban Daen Samakkhee, Khao Wong district, Kalasin Province (Bangkok Post, 2016). The project involved experimental plots to assist rice farmers who did not have enough water. A pond was dug on an area of 0.48 hectares with a water storage capacity of 12,000 cubic meters. This pond held sufficient rain water for 0.6 hectares of rice and 0.96 hectares of field crops. Even during the driest period, there was still water in the pond. The farm operated on the basis of integrated farming, which involved intercropping plants, and raising pigs and fish. The pond provided water to the rice fields throughout the planting season, resulting in a 70 percent increase in the rice yield. Water left from growing rice was used for field crops, fruit crops and vegetable cultivation. Fish were harvested when the pond water level was lowest, providing additional protein for family consumption. As a result, the farmers had food to consume all year round, and in good years had a significant surplus to sell at the local market. (Thailand International Development Cooperation Agency, 2018)

3.3.2 Hua Aow Organic Farm Group

At Ban Hua Aow village in Nakhon Pathom Province, a women's group farm organically. Using SEP principles of moderation, self-reliance and care for the environment, the Ban Hua Aow women started producing their own organic fertilizer for their own use and later for sale. Lower investment costs, increased soil fertility and their popular organic produce have freed them from debt. The group also earns income from selling saplings and a variety of organic sweets and other villages have followed their example (Ministry of Foreign Affairs of Thailand, 2017).

3.3.3 Rice Seed Bank

After attaining food security through New Theory farming, a group of rice farmers in Ban Sai Yai village in Nonthaburi Province have become self-reliant in rice seed production. They pool resources to select the best from their farms in order to produce high-quality rice seeds to share among themselves and sell to other farmers. This group also produces organic goods such as organic fertilizer pellets, organic liquid pesticides, shampoo and other items for members' household use and for sale (Ministry of Foreign Affairs of Thailand, 2017).

3.3.4 Sufficiency Economy in Community Development: The Inpaeng Network

In 1987, a small group of community leaders and local scholars met together in Ban Bua, a village in the hilly region of the far northeast of Thailand, to discuss a major problem: the more they invested in cash-cropping, the deeper they slipped into debt (United Nations Development Program, 2007). To address the community's ongoing problems, community leaders and local experts adopted His Majesty the King's suggested approach to agriculture beginning in 1987.

In the first stage, to achieve family-level food security, Ban Bua community stopped growing cassava and replaced it with food crops and rattan. The Village Foundation, an NGO, provided the villagers with the initial capital of 5,000 baht per family to buy seeds. The first year's crop earned each family an average of more than 30,000 baht. The community used part of the earnings to establish a small nursery to produce young rattan plants and grow backyard gardens of organic vegetables. Some villagers began dividing their lands according to the guidelines for production of rice, vegetables, fruit trees, fish ponds, mushroom nurseries and chicken coops. Within a few years, the community was able to produce enough for household consumption and to sell their products to other villagers (Thailand International Development Cooperation Agency, 2018).

In 1992, the second step began, with Ban Bua linking to other communities in came be be called the Inpaeng Network. In response to the expanded market provided by this network, the villagers increased their outputs. Some of them added new crops with the potential to serve as both food and extra income. The community engaged in local food processing to add value to their products. This included making makmao (a local herb)

into juice and wine, and producing shampoo and detergent from herbs. Community shops served as outlets for the increased varieties of products. As a result, the community paid off its debts while also improving quality of life (Thailand International Development Cooperation Agency, 2018).

Within five years, the third step was reached with the development of inter-community production chains. For example, local farmers sold their young makmao plants to grower groups and the latter sold the fruit to community factories that made makmao juice and wine. Then, the end products were branded and sold in community shops and outlets outside the village such as restaurants in Bangkok.

The community created microfinance groups to mobilize savings, lend money and provide affordable life insurance. The villagers sought technological knowledge beyond their community and campaigned for environmental conservation and the use of organic fertilizers made from waste materials.

Studies of the Inpaeng Network indicate that one key factor of their success was effective knowledge transfer. The villagers sought assistance from academic institutions, government agencies and international organizations and captured that knowledge in booklets, pamphlets and VCDs that villagers could use to improve their farming and community management practices.

The Inpaeng Network now covers communities in four provinces, totaling about 900 villages and over 100,000 members. The network's activities include agriculture, community enterprises, health care, environmental conservation and education (Thailand International Development Cooperation Agency, 2018).

3.3.5 Living Museums

These are research and study centres to restore degraded ecological systems in different parts of Thailand. Set up by His Majesty KingBhumibol Adulyadej, the royal development study centres, otherwise called Living Museums, are proof that it is possible to heal the seemingly beyond-repair environment cost-effectively by learning how nature works and from the treasure trove of local knowledge (Ministry of Foreign Affairs of Thailand, 2017).

At the present there are 6 “Living Museums” in all regions of the country. The centres are open for nearby communities and the public to learn about different techniques to reverse soil erosion, speed up natural reforestation, and boost biological diversity. Apart from serving as learning centres, they also function as one-stop service centres offering local people myriad types of assistance, including the setting up of cooperatives to process organic produce in order to generate more income. Group cohesiveness from these activities subsequently helps locals solve other problems on their own (Ministry of Foreign Affairs of Thailand, 2017).

3.3.6 Doi Tung Development Project

The Doi Tung project is one of the country’s biggest success stories in sustainable development. It has successfully tackled opium cultivation and deforestation in the mountainous North by tackling its root problem – the hill tribes’ harsh poverty and lack of life opportunities (Ministry of Foreign Affairs of Thailand, 2017).

Under the stewardship of the Late Princess Mother, the project reforested the once-barren Doi Tung mountain in Chiang Rai province and improved the hill peoples’ livelihoods by introducing alternative crops and turning them into popular products. Design and marketing assistance have also made their hill tribe handicrafts, coffee and other food products under the Doi Tung brand famous domestically and internationally. They also won a seal of approval from the United Nations Office on Drugs and Crime as one of the world’s best examples of alternative development (Ministry of Foreign Affairs of Thailand, 2017).

3.3.7 Doi Kham

The Doi Kham Food Products Co. buys farm products at fair prices from the hill tribe people in northern Thailand to support their sustainable farming. Doi Kham is a business outgrowth of the Royal Project Foundation which has successfully eradicated opium cultivation through crop substitution programmes. Meanwhile, Doi Kham continues to support the highlanders with new sustainable farming techniques to restore highland ecology and improve the farmers’ quality of life. Consumers also benefit from safe products from Doi Kham, proving that conscientious consumption can end farmers’ hunger and protect the environment (Ministry of Foreign Affairs of Thailand, 2017).

3.3.8 Forest for Food Security

If people benefit from the forest, they will become the forest guardians. This belief gave birth to community food bank projects to give food security to the hill peoples in northern Thailand by allowing them to collect edible plants from the forests for their own consumption. Initiated by Their Majesties King Bhumibol Adulyadej and Queen Sirikit, the first project using the forest as a community food bank was initiated at a remote hill village in Mae Hong Son Province. By protecting their community forests from land clearing and poachers, the villagers are allowed to use the forests sustainably. They also receive help to raise poultry, cattle, and fish to generate more income in order to lessen pressure on the forests (Ministry of Foreign Affairs of Thailand, 2017).

3.3.9 Pid Thong Lang Phra Foundation

Massive land-clearing in the mountainous Nan Province for corn plantations benefits the animal feed industry but destroys the rain catchment areas of the Chao Phraya river, Thailand's lifeblood. Meanwhile, the highland farmers remain trapped in hunger and poverty due to expensive seeds and uncontrollable corn prices (Ministry of Foreign Affairs of Thailand, 2017).

Denuded mountains in many villages in Nan have turned lush green once more, thanks to sustainable farming support from the Pid Thong Lang Phra Foundation. The foundation uses SEP principles, while addressing the hill peoples' problems and support their bottom-up decision to make change themselves based on moderation, reasonableness and self-immunity. The hill tribe farmers finally decided to stop land-clearing and adopt sustainable farming to attain food security. Hunger is now gone, the farmers' health has improved and many are now free from debt (Ministry of Foreign Affairs of Thailand, 2017).

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4. European agriculture and approach to sustainability

Consistent with agricultural approaches that emphasize holism, Oksen, Magid, and de Neergaard (2009) discussed an interdisciplinary approach to pairing research and education, with attention to the positive and negative aspects. The latter include the difficulties of taking the time and effort to integrate the disciplines into a more cohesive body; agreeing on common terminology and problem formulation; and personal relations, especially in an intercultural context. But more than these is the issue of balancing holism with specialization - emphasising the former risks superficiality, while emphasising the latter risks missing the relationships among different components as well as the insights available from disciplines outside one's own. Education and research which emphasise singularity may be compared to monoculture agriculture in that they all sorely lack diversity.

The positives outweigh the negatives, and make it worth focusing more on the positives. They include the opportunity to enhance and broaden the scope of understanding in one's specialization, as well as learn new skills and tools; to collaborate closely with others on a selected problem that is too complicated to deal with effectively through a single discipline; creating lasting personal and professional relationships; and when the education and research includes different nationalities, there is the opportunity for cross-cultural understanding. The educational examples below show the traditional top-down approach to learning and teaching.

The authors wrote about a programme called Sustainable Land Use and Natural Resource Management, or SLUSE. It is an interdisciplinary education and research programme focusing on mid-career professionals from several disciplines in a multi-cultural setting. Participants from closely related disciplines form teams to cooperate on complex problems through a combination of class work and field work. The authors reported on two watershed projects in northern Thailand with 22 Thai, Malaysian, and Danish participants forming four teams. Each team decided which sub-topics they needed to focus on, then collectively addressed the main research question, which was the relationship between upland and lowland farming, and how each land use type contributed to deforestation (Figure 5). The results reflect the breadth of the specialized disciplines, with at least one surprising finding – indicators of soil degradation such as severe erosion,

and negative effects on the quality of downstream water, could not be linked to upland cultivation., though the authors did not mention what became of the results, nor whether the teams made suggestions on how to deal with the deforestation. The Royal Forest Department and other government agencies, as well as local NGOs were involved, thus it was possible that this project had application benefits through the NGOs and the government agencies.

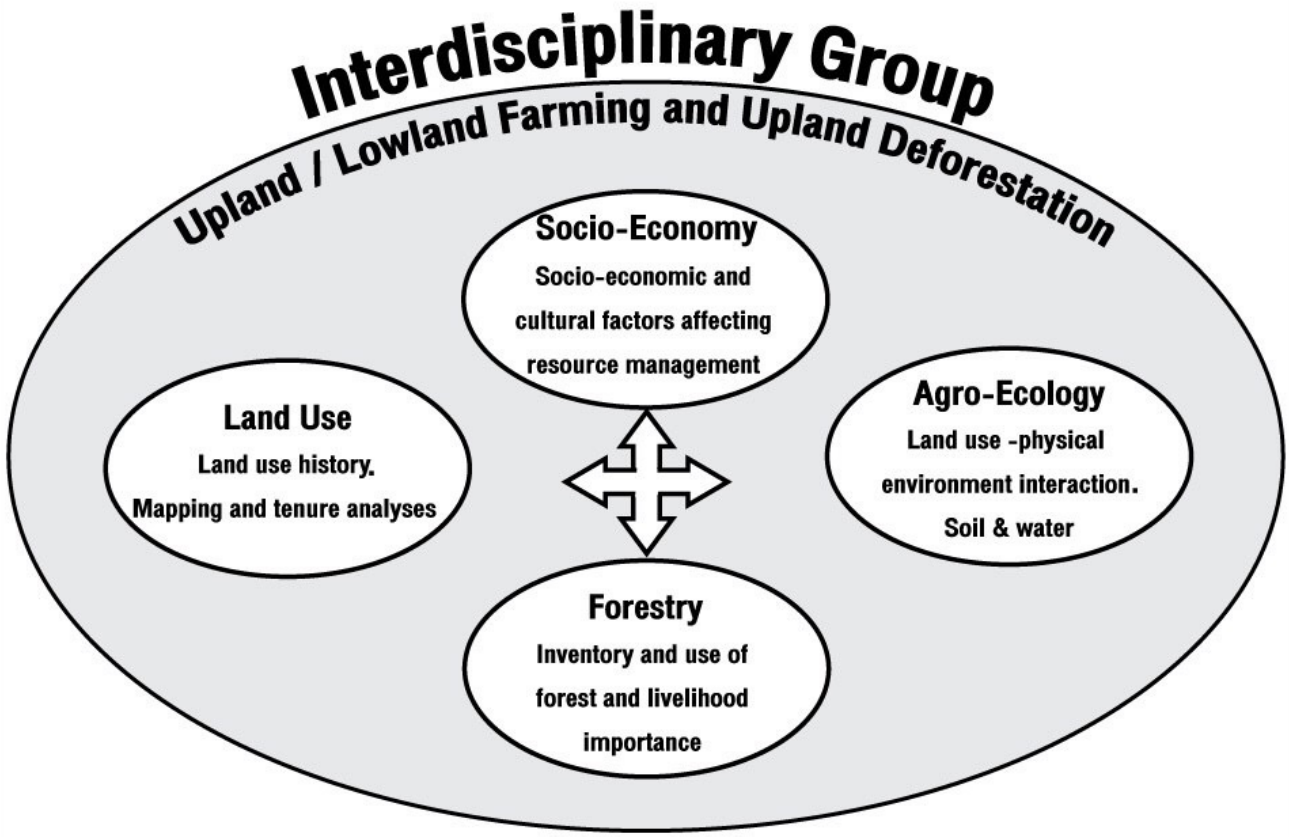

Figure 5. Illustration of the 4 SLUSE teams and their respective sub-topics.
Source: Oksen et al. (2009)

Given that SLUSE recruits mainly mid-career professionals, most graduates are perhaps better able than younger graduates just entering their respective fields to immediately apply what they learn in the program. The authors summarized responses to a questionnaire from 43% of the 112 Thais, mostly university lecturers and department heads, who have gone through the programme, though admitted that this could not be considered a representative sample. They wrote that students' evaluations were generally positive, and that they "appreciated the programme not only for the knowledge, skills, and experiences they have gained but also the relevance of these to their work." This last point, about the relevance to their work matters because they are in a better position than most people to shape policies regarding food systems and agriculture. According to the authors, most SLUSE graduates work in the environmental field. If this includes the agricultural sector, then they will perhaps exert influence on policymakers in government.

A different, yet also holistic education is described by Lieblein et al. (2007). This M.Sc. program in Agroecology, also for professionals, prepares them "to deal with complex challenges facing agriculture and food systems today and in the future." Learning is likened to moving up or down the rungs of a ladder (Figure 6). Instead of starting at the bottom of the ladder, these students start in the middle, then move up or down by exploring farms and food systems. They move down to learn skills and memorize facts and theory for every-day situations, and up for "visioning and implementing improvements." A corresponding, internal ladder requires students to be aware of thoughts and emotions, to be clear on their ethics, and to reflect on their experiences. Agroecology as a holistic discipline (in contrast to the style of farming discussed above in the form of agroforestry), must not focus solely on production. Students, therefore, must be able to synthesize and apply various types of information in an agri-food system. In one's professional capacity, one must understand how a healthy rural landscape functions and the importance of individuals, families, and communities. Thus, interdisciplinarity is important here, as it is in the SLUSE programme.

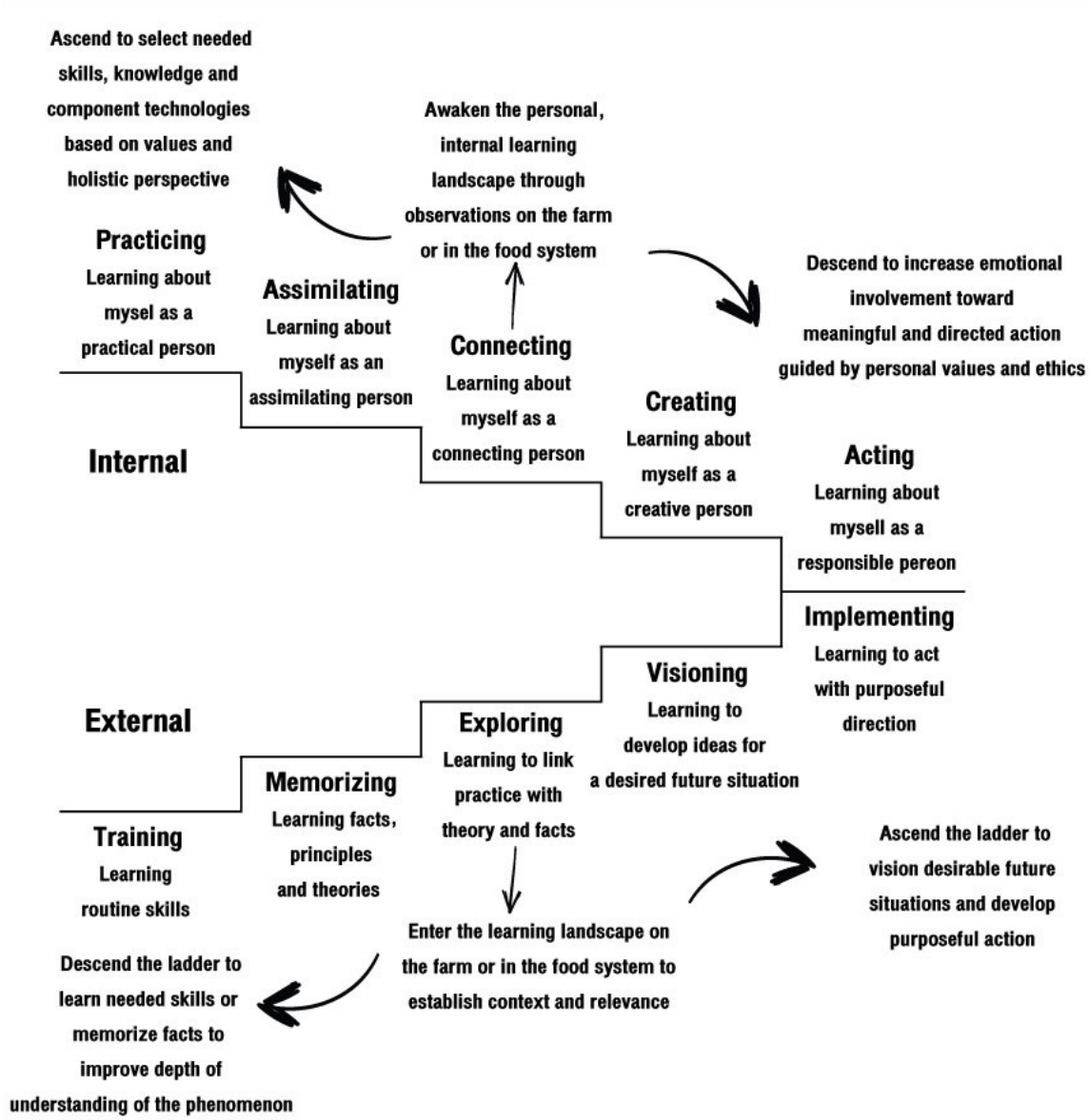

Figure 6. The 2 ladders, the entry points, movements, and details of each step.
Source: Lieblein et al. (2007).

4.1 General situation of agriculture in Europe; sustainability approach and EU policy

According to the European Commission's most recent agricultural census (EC, 2013), 12.2 million farms covered 40% of the 28 EU countries, with an average size of 14.2 hectares (or 88.75 rai). Half of all holdings were very small, i.e., less than 2 hectares, (or 12.5 rai), accounting for 2.5% of all EU farmland, while 2.7% of all holdings were very large, i.e. over 100 ha (or 625 rai), accounting for half of all EU farmland. A similar contrast is seen in economic output. The census reported that 44.6% of farms had an economic output of less than 2000 Euros, accounting for 1.4% of total agricultural economic output, while 1.9% of farms had an economic output of more than 250,000 Euros, accounting for 47.8% of total agricultural economic output.

In 1962, European countries established the Common Agricultural Policy (CAP) to support farmers and consumers across Western Europe. In the 1990s, the concept of sustainable agriculture entered the policy and has been periodically refined ever since (öhlund et al., 2015). According to the EC's website, the policy aims to:

- support farmers and improve productivity, so that consumers always have affordable food
- ensure that farmers are able to make a reasonable living
- help mitigate climate change
- assist with management of natural resources
- maintain rural areas and landscapes
- help rural economies by promoting jobs in farming and related sectors

A page on the EC's website, The common agricultural policy at a glance (n.d.), cited business and environmental uncertainties for spending 38% of its budget (or "1% of all public expenditure in the EU"), in the following ways [emphasis added]:

- *Income support.* Direct payments ensure income stability, and remunerate farmers for environmentally friendly farming and delivering public goods not normally paid for by the markets, such as taking care of the countryside

- *Market measures.* The EU can take measures to deal with difficult market situations such as a sudden drop in demand due to a health scare, or a fall in prices as a result of a temporary oversupply on the market
- *Rural development measures.* National and regional programmes address the specific needs and challenges facing rural areas.

The policy is regularly reformed, and implementation is preceded by extensive public debate. Not surprisingly with a policy that has far-reaching consequences for so many people all over the world, critics point to a wide range of shortcomings of the policy including its adverse effects on the environment, small farmers, and global food security. A 23-member interdisciplinary committee performed a "fitness check" on the most recent proposed CAP reform to determine its environmental and socio-economic impacts, and whether it meets its objectives and capacity to meet the UN's Sustainable Development Goals (Pe'er et al., 2017). They sought information regarding 6 themes, e.g., the CAP's effectiveness and efficiency, from over 300 sources, mainly peer-reviewed scientific articles, but also reports from the FAO and the EU. The authors' overall assessment was overwhelmingly negative; even positive results are tempered with negative aspects. Two examples: 1) although CAP has effectively decreased agrochemical use in older Member States, it supports increased use in new Member States, and 2) although it has had positive effects on farmers' income, this has been highly variable, and, some payments go to landowners who are not farmers.

The EC has specifics of the on-the-ground agri-environmental situation, of which only soil erosion and total organic land area examined here. Soil erosion caused by water has decreased in recent years, down from 16% of the EU's land area to about 11.4% that experiences moderate to high levels of erosion (EC, 2015). In 2016, 11.9 million hectares were counted as "organic areas", an increase of 18.7% over 2012 figures (EC, 2017). However, there was no separate accounting for "areas under conversion" and "fully converted areas". Fully organic farmland was 2.7%, whereas partially organic was 3.1%, of all farmland, with fully organic farms increasing by 0.34% from 2010 to 2013.

What role do Europe's educational institutions play in sustainable agriculture? Wals et al. (2013) ask, "What do we educate for in such a world when things change so fast and knowledge becomes obsolete before you know it? How do we prepare today's graduate for the world of tomorrow?" Their answer is that educational institutions must teach "new competencies", such as interdisciplinary problem-solving, addressing multiple stakeholder interests, participatory approaches in innovation, critical media literacy, and social responsibility in entrepreneurship, in addition to the long-established monodisciplinary sciences. They mentioned one university, in the Netherlands, that meets their criteria. According to the university's website, they strive to incorporate social and natural sciences for the benefit of people around the world (Wageningen University, n.d.). Wals (2015) argued that "sustain-abilities" are also necessary components of a "competence-based" education. These include the abilities to think systemically and adopt integrated views on situations, to question and analyse the status quo, to be creative, adaptable, and resilient, as well as to connect with people and even other species, and be passionate, moral, and ethical. To this may be added the ability to balance holism and specialization, as per Oksen et al. (2009).

In conclusion, perhaps these characteristics and abilities are most in need in order to create a world where unsustainable agriculture and food insecurity are rarities: the capacity to study and grasp a complex issue holistically, mindful of the relationships linking the various (perhaps conflicting) components, then to be able to communicate well with stakeholders about the various elements in the issue, and finally collaborate with relevant parties on implementing and following-up on a plan that is likely to create an outcome that is generally acceptable to all. Complicated, for sure. Traditional educational institutions are ill-equipped to prepare students and mid-career professionals for the task, yet unsustainable agriculture and hundreds of millions of people without adequate food are intolerable. This task is ideally one that all people in the world will embrace. But realistically, only those most passionate, and those most affected, are acting now and are going to act in the future. Farmers, NGOs, educational and research institutions, businesses, governments, and inter-government organisations all must understand and dutifully carry out their roles

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References

Agriculture, Natural Resource and Environment Planning Office. (2011). Definition of sustainable agriculture. Retrieved from: http://www.nesdb.go.th/ ewt_w3c/ ewt_dl_link. php?nid=2700 (accessed 12 February 2018)

Altieri, M.A. (1995). Agroecology: principles and strategies for designing sustainable farming systems. Retrieved from: http://www.agroeco.org/ doc/new_docs/ Agroeco_principles. Pdf (accessed 5 April 2018)

Altieri, M.A., Funes-Monzote, F. R., & Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. Agronomy for Sustainable Development, 32:1–13, doi: 10.1007/s13593-011-0065-6.

Barrett, C.B., Bellemare, M.F., & Hou, J.Y. (2010). Reconsidering conventional explanations of the inverse productivity–size relationship. World Development, 38: 88–97

Conrad, A. (2014). We are farmers: Agriculture, food security, and adaptive capacity among permaculture and conventional farmers in Central Malawi. PhD Thesis. Retrieved from: http://www.neverendingfood.org/ wp-content/uploads/2015/03/ Conrad-FINAL-Dissertation-We-are-farmers.pdf (accessed 18 May 2018)

Dawe, D. (2015). Agricultural transformation of middle-income Asian economies: Diversification, farm size and mechanization. ESA Working Paper No.15-04. Rome, FAO.

De Schutter, O. (2010). Report submitted by the Special Rapporteur on the right to food. Retrieved from: http://www.srfood.org/images/stories/pdf/officialreports/ 20110308_a-hrc-16-49_agroecology_en.pdf (accessed 18 May 2018)

European Commission. (2013). Agricultural Census 2010 – Main Results. Retrieved from: ec.europa.eu/eurostat/statistics-explained/index.php/Agricultural_census_ 2010_-_main_results#Agricultural_holdings(accessed 5 April 2018)

European Commission. (2015). Agri-environmental indicator - soil erosion.Retrieved from: ec.europa.eu/eurostat/statistics-explained/index. php?title=Agrienvironmental_ indicator _-_soil_erosion (accessed 5 April 2018) European Commission. (2017). Organic farming statistics. Retrieved from: ec.europa.eu/ eurostat/statistics-explained/index.php?title=Organic_farming_statistics#Total_ organic_area (accessed 5 April 2018)

FAO. (2014a). Contribution to the 2014 United Nations. Economic and Social Council (ECOSOC) Integration Segment. Retrieved from: http://www.un.org/en/ecosoc/ integration/pdf/foodandagricultureorganization.pdf (accessed 5 April 2018)

FAO. (2014b). Building a Common Vision for Sustainable Food and Agriculture. Rome, FAO.

FAO. (2015). Soils Are Endangered, But the Degradation Can be Rolled Back.News article. Retrieved from: http://www.fao.org/news/story/en/item/357059/icode/

FAO, IFAD & WFP. (2014). The State of Food Insecurity in the World 2014.Strengthening the Enabling Environment for Food Security and Nutrition.Rome, FAO.

FAO, IFAD, UNICEF, WFP & WHO. (2017). The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security. Rome, FAO.

Ferguson, R.S. & Lovell, S.T. (2014). Permaculture for agroecology: Design, movement, practice, and worldview. A review. Agronomy for Sustainable Development, doi 10.1007/s13593-013-0181-6.

Giovannucci, D., Scherr, S., Nierenberg, D., Hebebrand, C., Shapiro, J., Milder, J., & Wheeler, K. (2012). Food and Agriculture: the Future of Sustainability. A Strategic Input to the Sustainable Development in the 21st Century (SD21) Project. New York: United Nations Department of Economic and Social Affairs, Division for Sustainable Development.

Holmgren, D. (2015). Permaculture: Principles and Pathways Beyond Sustainability. Australia: Melliodora Publishing.

Jitsanguan, T. (2001). Sustainable Agricultural Systems for Small-Scale Farmers in Thailand/ Implications for the Environment. Retrieved from: http://www.fftc.agnet.org/library. php?func=view&id=20110718190247(accessed 9 May 2018)

Kasem, S., & Thapa, G.B. (2012). Sustainable development policies and achievements in the context of the agriculture sector in Thailand.Sustainable Development, 20: 98-114.

Kittithurakul, Y., Bamrung, S., Kaewwongsri, S., Thongkham, P., Wairat, R.,Nattarom, N., Utamamuni, W. (2014). การศึกษาเปรียบเทียบมิติความยั่งยืนเชิงบูรณาการระหว่างสวนยางพาราแบบวนเกษตรกับสวนยางพาราเชิงเดียว. [A comparative study of integrated dimensions of sustainability between agroforest and monoculture rubber plantations.] (In Thai.) Bangkok: Sustainable energy foundation.

Kumpa, L. (2015). Sustainable agriculture and food security in Thailand: National government perspectives and policies. Presentation at Higher Education for Sustainable Agriculture and Food Security in Thailand and Southeast Asia, Chulalongkorn University School of Agricultural Resources (CUSAR), Bangkok, Thailand.

Kumpa, L. (2017). Sustainable agricultural development under the 12th National Social and Economic Development Plan (2017-2021). Retrieved from: http://www.nfc.or.th/wp-content/uploads/download-manager-files/seminar-60-036.pdf (accessed 12 February 2018).

Leturque, H. & Wiggins, S. (2011). Thailand's Progress in Agriculture: Transition and Sustained Productivity Growth. London: ODI publications. Retrieved from: https://www.odi.org/sites/odi.org.uk/files/resource-documents/11560.pdf (accessed 9 May 2018)

Lieblein, G., Breland, T.A., Østergaard, E., Salomonsson, L., and Francis, C. (2007). Educational perspectives in agroecology: Steps on a dual learning ladder toward responsible action. NACTA Journal. Retrieved from: https://www.nactateachers.org/attachments/article/269/Leiblein_March_2007_NACTA_Journal-7.pdf (accessed 9 May 2018)

Lowder, S.K., Skoet, J., & Raney, T. (2016). The number, size, and distribution of farms, smallholder farms, and family farms worldwide. World Development, 87: 16-29. doi.org/10.1016/j.worlddev.2015.10.041.

Lowdermilk, W. C. (1948). Conquest of the land through seven thousand years. U. S. Department of Agriculture Soil Conservation Service, S.C.S. MP-32. Retrieved from: soilandhealth.org/wp-content/uploads/01aglibrary/010119lowdermilk.usda/cls.html (accessed 8 May 2018)

Ministry of Agriculture and Cooperatives – MOAC (2016). Agricultural development plan during the 12th National Social and Economic Development Plan (2017-2021). Bangkok: MOAC.

Ministry of Foreign Affairs. (2015). Sufficiency Economy Philosophy: Thailand's Path towards Sustainable Development Goals. Ministry of Foreign Affairs,Kingdom of Thailand. Retrieved from: http://www.mfa.go.th/dvifa/contents/files/articles-20170626-142701-203959.pdf (accessed 1 February 2018)

Mollison, B., (2000). Introduction to Permaculture. Tasmania, Australia: Tagari Publications.

Mongsawad, P. (2010). The Philosophy of the Sufficiency Economy: A Contribution to the Theory of Development. Asia-Pacific Development Journal. 17:123-143.

Mulvany, P. (2017). Agricultural biodiversity is sustained in the framework of food sovereignty. Biodiversity, 18:2-3, 84-91, doi: 10.1080/14888386.2017.1366872.

National Economic and Social Development Board - NESDB. (2004). An Introduction Note:Sufficiency Economy. Office of the National Economic and Social Development Board,Thailand?? (accessed 15 May 2018)

National Economic and Social Development Board - NESDB. (2007). Sufficiency Economy Implications and Application. Office of the National Economic and Social Development Board Retrieved from:http://www.nesdb.go.th/ewt_dl_link.php?nid=2621 (accessed 1 February 2018)

National Economic and Social Development Board – NSEDB (2016). The 12th National Social and Economic Development Plan (2017-2021). Bangkok: Office of the Prime Minister. (accessed 1 February 2018)

Nelles, W., Visetnoi, S. (2016). Thailand's Department of Agricultural Extension and Agrochemical Dependency: Perspectives on contributing factors and mitigation strategies. Journal of Agricultural Education and Extension, 22: 225-240.

Office of Agricultural Economics. (2018). เศรษฐกิจการเกษตรรายสินค้า [List of Agricultural Poducts.] Ministry of Agriculture and Cooperatives, Bangkok, Thailand. Retrieved from: http://www.oae.go.th/assets/portals/1/files/ebook/Commodity60.pdf (accessed 30 May 2018)

Öhlund, E., Zurek, K. & Hammer, M. (2015). Towards sustainable agriculture?The EU framework and local adaptation in Sweden and Poland.Environmental Policy and Governance, 25: 270–287 doi: 10.1002/eet.1687

Oksen, P., Magid, J., & de Neergaard, A. (2009). Thinking outside the box:Interdisciplinary integration of teaching and research on an environment and development study programme. Interdisciplinary Science Reviews,34: 309–326. doi: 10.1179/030801809X12529269201165 Panyakul, V. & Kongsom, C. (2015). โครงการศึกษาและจัดทำข้อมูลสถานการณ์ การผลิตและการตลาดสินคข้าอินทรีย์ [Thailand's Organic Production and Market Situations (Thai language)]. Green Net. Retrieved from: https://www.researchgate.net/profile/Vitoon_Panyakul/ publication/305681176_Thailand%27s_Organic_Production_and_Market_Situations_Thai_language/links/5848251e08ae95e1d16651d8/Thailands-Organic-Production-and-Market-Situations-Thai-language.pdf (accessed 9 May 2018)

Pe'er, G., Lakner, S., Müller, R., Passoni, G., Bontzorlos, V., Clough, D., & Zinngrebe (2017). Is the CAP fit for purpose? An evidence based fitness-check assessment. Leipzig: German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig.

Puntasen, A. (2017). From Wealth to Well-being and Finally Nibbana: A bridge from Traditional to Buddhist Economics. Prajñā Vihāra. 18 : 98-140.

Quan, J. (2011). A Future for Small-scale Farming. The Government Office for Science. Natural Resources Institute, University of Greenwich, London.Foresight Project on Global Food and Farming Futures. Science review:SR25. Retrieved from: https://www.nri.org/images /documents/news2011/11-570-sr25-future-for-small-scale-farming.pdf (accessed 30 April 2018)

Shenggen, F. & Chan-Kang, C. (2005). Is small beautiful? Farm size, productivity,and poverty in Asian agriculture. Retrieved from: https://sci-hub.tw/https://doi.org/10.1111 /j.0169-5150.2004.00019.x (accessed 9 May 2018)

Smith, A., Snapp, S., Chikowo, R., Thorne, P., Bekunda, M., & Glover, J. (2017).Measuring sustainable intensification in smallholder agroecosystems: A review. Global Food Security, 12: 127–138.

Sugiyama, M. (2017). Agroforestry Coffee Production in Northern Thailand:livelihood system transformation and institutional changes. (Master's Thesis). Norwegian University of Life Sciences. Retrieved from: https://brage.bibsys.no/xmlui/handle/11250/2443264 (accessed 5 April 2018)

Thailand International Development Cooperation Agency. (2018). Thailand's Best Practices and Lessons Learned in Development. Volume 1. Ministry of Foreign Affairs, Thailand.

Third World Network & SOCLA. (2015). Agroecology: Key Concepts, Principles, and Practices. Penang, Malaysia: Third World Network. Retrieved from:http://agroeco.org/wp-content/uploads/2015/11/Agroecology-training-manual-TWN-SOCLA.pdf (accessed 9 May 2018)

UN Convention to Combat Desertification. (2017). Global land outlook. Bonn,Germany. Retrieved from: https://static1.squarespace.com/static/5694c48bd82d5e9597570999/t/ 59e9f992a9db090e9f51bdaa/1508506042149/GLO_Full_Report_low_res_English.pdf (accessed 9 May 2018)

University of California, Davis. (n.d.). What is sustainable agriculture? http://asi.ucdavis.edu/ programs/sarep/about/what-is-sustainable-agriculture/ (accessed 5 April 2018)

United Nations Development Program. (2007). Thailand Human Development Report 2007: Sufficiency Economy and Human Development. United Nations Development Program, Bangkok, Thailand.

Wageningen University. (n.d.) Home page. Retrieved from: https://www.wur.nl/en/wageningen-university.htm (accessed 9 May 2018)

Wals, E.J.A. (2015). Developing sustainability competence and 21st century capacities through Transformative Agricultural Education. Paper Presented at Conference: Agricultural Higher Education in the 21st Century,CIHEAM, Zaragoza, Spain.

Wals, A., Mulder, M., & Eernstmann, N. (2013). How to educate in a changing world? Towards competence-based tertiary agricultural education. http://knowledge.cta.int/Dossiers/S-T-Policy/Reshaping-tertiary-agricultural-education/Feature-articles/How-to-educate-in-a-changing-world-Towards-competence-based-tertiary-agricultural-education (accessed 5 April 2018)

Western SARE, USDA. (n.d.). What is sustainable agriculture? https://www.westernsare.org/About-Us/What-is-Sustainable-Agriculture (accessed 5 April 2018)

World Health Organization (WHO). (2017). Fact sheet: Obesity and overweight. www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight.(accessed 9 May 2018)

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