CHAPTER 2

LITERATURE REVIEW

This chapter will explore the literature that is relevant to understanding the process of, and interpreting the results of this convergent study, covered by this chapter. Following a major topic included in this review literature;

2.1 Sustainable agriculture concept

2.2 Types of sustainable agricultural practices

2.3 Low input agriculture

2.4 Innovation concept

2.5 Understanding resilience concept

2.6 Knowledge management

2.7 Related study

2.1 Sustainable agriculture concept

Sustainable agriculture is sustained to integrate three main goals environmental health, economic profitability, and social and economic equity. A variety of philosophies, policies and practices have contributed to these goals. People in many different capacities, from farmers to consumers, have shared this vision and contributed to it. Despite the diversity of people and perspectives, the following themes commonly weave through definitions of sustainable agriculture.

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. Therefore, stewardship of both natural and human resources is of prime importance. Stewardship of human resources includes consideration of social responsibilities such as working and living conditions of laborers, the needs of rural communities, and consumer health and safety both in the present and the future. Stewardship of land and natural resources involves maintaining or enhancing this vital resource base for the long term.

Making the transition to sustainable agriculture is a process. For farmers, the transition to sustainable agriculture normally requires a series of small, realistic steps. Family economics and personal goals influence how fast or how far participants can go in the transition. It is important to realize that each small decision can make a difference and contribute to advancing the entire system further on the "sustainable agriculture continuum."

Finally, it is important to point out that reaching toward the goal of sustainable agriculture is the responsibility of all participants in the system, including farmers, laborers, policymakers, researchers, retailers, and consumers. Each group has its own part to play, its own unique contribution to make to strengthen the sustainable agriculture community.

The remainder of this document considers specific strategies for realizing these broad themes or goals. The strategies are grouped according to three separate though related areas of concern: farming and natural resources, plant and animal production practices, and the economic, social and political context. They represent a range of potential ideas for individuals committed to interpreting the vision of sustainable agriculture within their own circumstances (Anonym, 1997).

According to McConnell (1997) sustainability is the capacity of a system to maintain its productivity/profitability at a satisfactory level over a long or indefinite time period regardless of year-to-year fluctuation (i.e. of its short-term instability). The concept involves the evaluation of farm activities and systems in terms of their (interrelated) ecological, economic, and socio-cultural sustainability over long time periods of many years.

FAO (1991) defined sustainable agriculture as management and natural resources conservation (soil, water, germ plasmas, crops and livestock) and changes of technological orientation as well as institutions to satisfy human needs at present and for future generations. TAC/CGIAR (1988) defined sustainable agriculture as the successful management of resources for agricultural farming that can help to meet the ever changing human needs and to conserve or improve the quality of the environment and also to sustain natural resources.

Sustainability is a process and not an event (Hoon, 1997). Sustainability is a multidimensional concept. Lefroy (2000) mentioned that the concept of sustainability is a dynamic concept in term of time and place, where sustainability is one area might not be the same with the other, and what have been considered sustainable at one time might not be longer sustainable in the future due to the change of condition and attitudes. In the context of farming systems, it may relate to physical, biological, economic and social attributes. Kaine and Tozer (2005) cited by Lien *et al.* (2007) stated that applying this notion to the choice between alternative farming systems, could specify to economic sustainability which has meaning that the ability of the system to continue into the future, and at the level of the individual farm, primarily means that the farm business must remain financially viable while providing an acceptable livelihood for the family farm.

American Society of Agronomy (1989) defined sustainable agriculture is one that, over the long term, enhances environmental quality and the resource base on which agriculture depends; provides for basic human food and fiber needs; is economically viable; and enhances the quality of life for farmers and society as a whole.

2.2 Types of sustainable agricultural practices

Agro ecosystems are communities of plants and animals interacting with their physical and chemical environments that have been modified by people to produce food, fiber, fuel and other products for human consumption and processing. Agro ecology is the holistic study of agro ecosystems, including all environmental and human elements. It focuses on the form, dynamics and functions of their interrelationships and the processes in which they are involved. An area used for agricultural production, e.g. a field, is seen as a complex system in which ecological processes found under natural conditions also occur, e.g. nutrient cycling, predator/prey interactions, competition, symbiosis and successional changes. Implicit in agroecological research is the idea that, by understanding these ecological relationships and processes, agro ecosystems can be manipulated to improve production and to produce more sustainably, with fewer negative environmental or social impacts and fewer external inputs (Altieri, 1994). In this research identify five types of sustainable agriculture practices are described as following;

1) Integrated farming

Integrated farming is a farming system that has at least two different agricultural activities in the same field, for example, paddy and fish raising, or pig farming, fish raising and vegetable plantation. Practicing various agricultural activities at the same time helps reduce costs, that is, the economy of scale is working. For instance, manure and other farm residues can be used as fertilizer when planting crops. This system is suitable for a small-scale farmer, letting him make best use of his limited field area. In practice, the system is widely used in the central area of Thailand, where there are a plenty of water resources.

2) Organic farming

The International Federation of Organic Agriculture Movements (IFOAM) defines organic agriculture as: "Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved". Since the 1970s, organic agriculture has developed into a market concept, with standards, certification and finally, government regulation in most developed countries.

It is clear that the practice of organic agriculture, rather than confining itself to technical issues of agronomy, livestock management and the farm business, is intended to deliver much wider benefits to the agricultural system, the environment, society, the economy and institutions. Some of these benefits are presented in Table 1.

Table 2.1 Potential benefits of organic agriculture

Parameter	Potential benefits
Agriculture	Increased diversity, long term soil fertility, high food quality, reduced pest/disease, self-reliant production system, stable production
Environment	Reduced pollution, reduced dependence on non-renewable resources, negligible soil erosion, wildlife protection, resilient agro ecosystem, compatibility of production with environment
Social conditions	Improved health, better education, stronger community, reduced rural migration, gender equality, increased employment, good quality work
Economic conditions	Stronger local economy, self-reliant economy, income security, increased returns, reduced cash investment, low risk
Organizational/Institutional	Cohesiveness, stability, democratic organizations, enhanced capacity

Source: IFOAM, 1996.

Movement in organic farming

The movement in organic farming is the phenomenon of conventionalization. This implies a development in which organic farms increasingly resemble industrial conventional farms. Some features of this trend include: farm enlargement, increasing debt loads with increasing capital intensification, replacement of labor by machinery and other industrial inputs, and export-oriented marketing rather than local selling (Hall and Mogyorody, 2001). Examples of this trend have been reported both in Europe (Tovey, 1997) and North America (Guthman, 1998, 2000; DeLind, 2000; Hall and Mogyorody, 2001). As part of this process, a differentiation of the organic market can be seen where small-scale organic farms focus on local markets while at the same time larger farms can exploit the global organic market. They do not necessarily compete with each other (Coombes and Campbell, 1998; Hall and Mogyorody, 2001). However, the input-substitution approach to organic farming practiced by large-scale farms in which conventional inputs are merely substituted for organically approved inputs is supported by the existing economic system. Thus, farmers choosing this path of organic farming have a competitive advantage (Allen and Kovach, 2000). Therefore, the differentiation of the organic market may soon disappear as small farms can no longer compete. The organic principles represent a break with the 'high-external input and high output' paradigm and organic conversion requires farmers to abandon much of the knowledge they have from conventional production (Roling and Jiggins, 1998). Organic farming is generally considered to be ecologically benign and to favor rural economies and development (cf. Jansen, 2000; Pugliese, 2001). However, if trends towards more input substitution and increasing integration into mainstream structures continue (Lehmann, 2000; Rigby and Caceres, 2001) the contribution of organic farming to rural employment and the environment will be reduced. Thus, if this trend continues, organic farming risks losing the capacity to build resilience in farms and agro-ecosystems. If farms and agro-ecosystems lose resilience they cannot contribute to sustainable development.

3) Natural farming

Natural farming's concept is no tillage, no application of fertilizer, herbicide and insecticide. For the ecological preservation aspect, we can say that natural farming is ultimate sustainable agriculture practice. At the present, there is nowhere perfectly practicing the natural farming system in Thailand. Yet, a few natural farming cases can be seen in the Northeastern area such as local vegetables, forest products (mushrooms, bamboo shoots, nuts etc.)

4) Agroforestry

Agroforestry is an idea to put agriculture and a forestation together, that is, to plant cash crops or raise livestock while planting trees in the same area. Its objectives are not only to increase farmers' income, but also to decrease deforestation induced by agricultural area expansion. Besides, it also helps improve the soil quality and biodiversity. Agro forestry is conducted in the Northern and Southern areas. The concept of agroforestry implies there are land use options that include various approaches for combining crop, tree and forest production. Three generic types of agroforestry options include:

• Annual and tree crops in the same field. Examples include "classic" forms of agroforestry, such as "alley cropping", contour hedgerows (some promotion), or "live fences".

• Annual crops and forest in the same field. Examples include forms of rotational shifting cultivation, such as traditional Lua and Karen practices in northern Thailand.

• Tree crops and forest in the same field. Now called "agroforests", examples would include "miang" tea gardens in northern Thailand. The balance of "agricultural" trees can become large in systems that "mimic" forest structure such as mixed durian agro forests in Uttaradit, in some "home gardens", or in some of the more complex mixed forms of "natural farming".

5) New Theory Farming

New Theory farming is an agricultural system proposed by His Majesty the King Bhumiphol Adulyadej in 1993. Its basic concept is self-sufficiency. Crop selling is a next step after attaining self-sufficiency. The concept is most appropriate to the farmers that have limited small field and lack water resources. According the New Theory, the field will be divided into 4 parts in the approximate ratio of 30:30:30:10. The first is to make for fish pond. The second 30% is for field crops and vegetables. The third 30% is rice paddy for self-consumption. The last 10% is living space and livestock raising.

Since 1995 the Office of the Royal Development Projects Board has started to introduce the New Theory farming system to farmers over the countries through a number of royal projects. With the cooperation with royal development study centers located in each region, local agricultural cooperatives and government units such as the Department of Agricultural Extension, the royal projects distribute seedlings or livestock breeds that have been developed and proved suitable for the area.

6) Natural Farming

Today agricultural potential points to a more environment–friendly system known as organic agriculture. Different groups using organic techniques give the term “organic agriculture” slightly different definitions. In general, however, it refers to the practice of using organic matter in place of relying on chemicals. Regretfully, the many regulations applied to this practice and its production input – organic fertilizers and pesticides – mean that the cost of using these techniques is very high; which, in turn, means that implementing them in poor counties with limited resources is difficult. Countries able to invest in agriculture and good agricultural equipment achieve better results and are more likely to make a profit in commercial organic enterprises.

Tropical countries in South East Asia are at an advantage because they have a good climate for year-round farming; however, they experience a major problem with low levels of organic matter in their soil. This is because organic matter is often washed away by frequent rain. The organic matter is broken down by enormous amounts of microorganisms so rapidly that its accumulated mass remains on top of the soil rather than in the soil like it does in countries with temperate climates. Low organic matter is the main reason for low fertility in tropical soils, which along with wide-spread pest problems cause many farmers to choose chemical agriculture over more environment–friendly systems.

That said, the negative outcomes of chemical agriculture today (for example, high production costs, low or uncertain market prices, excess chemical contamination, and sickness among farmers) have led to the change of some agricultural production systems in Thailand and other countries around the world. Alternative agriculture, including production systems known as “organic agriculture,” “sustainable agriculture,” “integrated farming,” “New Theory Agriculture,” “agroforestry” and “natural farming,” is replacing old systems. “Natural agriculture” is one of the alternative forms that has played an important role in Thai society in the last 20 years. Natural agriculture concepts *introduced by The One-Straw Revolution by Fukuoka* (1987), *Kyusei Nature Farming* (1988) and *Korean Natural Farming* (1997) have brought significant transformation to agriculture in Thailand. The fact that both academics and farmers today acknowledge the use of fermented plant juice, indigenous microorganisms, wood vinegar, and composting pits for pig rearing, etc. as viable production techniques gives testimony to this transformation. The ease with which these techniques can be put into practice is leading to their acceptance and the instigation of organic farming by Thai farmer. The integration of these different streams of knowledge is also contributing to the creation of a sustainable agriculture. Some of the methods used most widely in Thailand are discussed below.

Fukuoka's Natural Farming

Masanobu Fukuoka's system of natural farming is a well-known concept among Thai farmers and academics. After the success of his book, The *One-Straw Revolution* (1987), Fukuoka received the Magsaysay Award in 1988. His agriculture system's four main principles: 1) no plowing , 2) no fertilizing, 3) no weeding and 4) no pesticides, represent the complete opposite of most modern agriculture principles. Fukuoka, a former plant pathologist had become farmer. He spent more than 50 years endeavoring to revive field soil and ecology and to enrich the quality and quantity of plants and crops.

Masanobu Fukuoka was born in 1913, in a small village on the island of Shikoku in Southern Japan. He graduated university in microbiology, specializing in plant pathology, and went to work as an agricultural researcher at the customs office in Yokohama inspecting plants being imported and exported. He resigned from work at age 25 and returned to his country home to be farmer. The following 50 years or more were spent developing his Natural Farming method.

Fukuoka brought his experience in research from the laboratory to the fields. He discovered that farmers believed that the only effective way to add oxygen into the soil was to plow with a tractor, hoe, or shovel. In his book, he explained that the more farmers plow, breaking the soil into smaller and smaller pieces, the more the separated particles fill in existing air spaces. For certain soil types, this creates soil pan or compacted soil. Fukuoka went on to explain that weeds can do the job of aerating the soil. Their roots can burrow deep down 30-40 centimeters and bring oxygen and water up through the soil. When these roots die off they become food for microbes, which in turn breed, allowing earth worms, followed by moles and other vertebrates to increase in number. These creatures help plow the soil naturally, making it fertile and helping to restore it without human effort. Fukuoka's theory followed the natural rule and aimed to restore fertility by emphasizing the retention of ground cover (playing down the need for compost) as the most natural way to improve soil condition. (Fukuoka, 2000A)

Fukuoka's Natural Farming method

(1) No mechanized plowing

(2) No chemical fertilizer. Use of ground cover crops such as legume covers. Use of rice straw or mulches for covering ground rather than prepared compost or manure.

(3) No weeding. Weeds are suppressed with ground cover crops or mulches.

(4) No chemical pesticides. Diseases and pests controlled by natural mechanisms.

The best way to control diseases and pests is to grow plants in ecological conditions that are balanced. Fukuoka believed in nourishing soil and maintaining the natural conditions of living organisms without separating them from their own systems. He said "If we change our way of cultivating grain, we also change our food's appearance, society and life style." His "natural farming" ideas do not mean nature is left to manage itself without the help of farmers. Rather, they encourage farmers to learn and understand nature and work in cooperation with it instead of against it to decrease unnecessary inputs. The purpose of farming is not simply to produce high yields. The quality of the produce must be considered as well. Fukuoka said "Farming with the feeling of freedom at the end of each day is the original way of farming. Humans don't exist by food alone." (Fukuoka, 1987)

Advantages and limitations of Fukuoka's Natural Farming (Fukuoka, 2000C)

Advantages

(1) Nature's balance is not destroyed.

(2) No pollution to human and animals.

(3) Able to restore natural resources.

(4) Low production costs and labor.

Limitations

(1) Time required learning and understanding natural conditions.

(2) Time required observing results.

(3) Farmers must work hard and be patient.

(4) Produce has blemishes and is not perfect-looking like produce from modern Farming.

(5) Production does not yield large volumes to sell.

Kyusei Nature Farming

Kyusei Nature Farming is another organic farming technique Japan. The Kyusei Nature Farming system is also widely used in Thailand. Mokichi Okada's philosophy and principle emphasizes the maintenance of soil, acknowledging nature's own power. "Nature farming is the making of living soil" and the bringing of the agricultural production system and nature into harmony. The ecology is important and if unharmed will create a sustainable environment and enhance human health. (Senanayake and Sangakkara, 1997)

Mokichi Okada was the founder of Sekai Kyusei Kyo' a religious organization that promotes the Kyusei Nature Farming system with the goal of eliminating the suffering of mankind. Okada had studied and researched natural farming methods for many years. Early on, he came to realize how much the environment and the quality of food are adversely affected by the use of chemicals. He anticipated that "in the future, fruits and vegetables available in the market would not be suitable for consumption" and stated that pollution of soil, water and air in the world would affect mankind and the environment. This pollution has been seen as a product of The Green Revolution which promoted the use of intensive chemical fertilizers and pesticides in many areas in order to provide enough food for the rising human population.

After the end of World War I, the need for agricultural chemicals significantly increased. Japanese Government's agricultural production policy was to use chemical fertilizers to create enough produce for the country's population. In 1935, after Japan lost the war and the country was closed, Okada established Kyusei Nature Farming and practiced his methods secretly on private farm land. He had been arrested previously by the Japanese government for not following the government's policies.

Okada's nature farming principles give primary importance to soil. Okada observed soil in natural forests and identified different layers. Concerning the layers, he noted the following:

The 1st layer is covered with dry leaves and sticks.

The 2st layer has dry leaves and sticks in the process of decay.

The 3st layer is composed of decayed dry leaves and sticks mixed with soil.

The 4st layer is composed soil without and organic matter.

The third layer of decayed leaves and sticks mixed in the soil contains small living organisms both visible and invisible to the naked eye. This layer of soil has lots of fibrous roots and root hairs. When sampled, the odor is similar to the odor of mushrooms. Okada called this layer 'living soil'

Okada's Nature Farming method proposes to:

(1) Produce good products that don't harm human health.

(2) Preserve the soil while producing higher yield each year.

(3) Produce as much yield as chemical farming does and promote better economic returns to the farmers.

Only the first two points proposed were proven successful at the beginning of his trials. Okada found that he could not produce yields competitive with those of chemical farming because his method required higher investment while producing lower yields. Also, he could not control diseases or pests. For these reasons Kyusei Natural Farming did not receive wide-spread attention at that time.

Principles of Kyusei Nature Farming

Mokichi Okada's Nature Farming system follows principles that govern the ecosystem and soils of the natural forest. Of those, his approach focuses on three:

1) Mulching: Mulching planting beds helps:

(1) Maintain soil moisture and protect surface soil from being washed away.

(2) Montrol weeds.

(3) Promote a good environment for microorganism activity.

(4) Provide nutrients for plants when organic matter in mulch breaks down.

2) No plowing

Plowing soil destroys the ecosystem for microorganisms and dries the soil out. Less fertile soil at the bottom of the soil layers is turned over to the surface. Plowing is still necessary on some occasions, however, to get rid of weeds and as an easy way to make garden beds when soil is very hard.

3) No chemical use

The disuse of chemicals is the most important way to begin returning soil to its natural state. When soil is natural, its power Okada's ideas teach that chemical substances used alongside natural farming techniques fail to return soil to its natural condition and are, therefore, not sustainable.

Okada practiced Kyusei Nature Farming for 40 years but was unable to attain his third goal of producing yields comparable to those resulting from chemical farming until 1982 when Prof. Dr. Teruo Higa, a graduate of the University of Ryukyu in Okinawa, discovered the process for making Effective Microorganisms of EM. EM is a product resulting from the combination of more than 80 different types of microorganisms. The discovery of this combination made Okada's third goal possible and brought about the wide-spread practice of his Natural Farming system. By significantly improving soil condition, EM helps control plant pests and diseases, cutting down production investment and increasing harvest yields.

Kyusei Nature Farming in Thailand

In 1968, Kazuo Wakugami, a Japanese missionary, comes to Thailand. In 1988 he created a foundation called "Foundation of Public Service with Religious Activity Sekeikyuseikyo" Its mission was to help Thai farmers, who formed a majority of the population, and to spread the Kyusei Nature Farming system to other countries.

Effective Microorganisms or EM was introduced to Thailand in 1986. In 1988, a training and promotion center set up in the Keangkoi District in Saraburi Province under the care of the new foundation saw the use of EM spread all over the country reaching into agriculture, livestock and fishery practices.

Today, however, certain government sectors that are responsible for agriculture in Thailand such as the Agriculture Department of the Ministry of Agriculture and Cooperatives do not accept its use in agriculture because it is not a registered product. Conflictingly, other government sectors and state enterprises accept EM as a natural farming technique and promote it widely among farmers and other communities. No less than 30,000 people each year demonstrate interest in learning the Kyusei Nature Farming technique. (Senanayake and Sangakkara, 1997)

2.3 Low input agriculture

Parr *et al.* (1990) affirmed that low input farming systems can be determining the sustainability in farming systems. Low input of agriculture here means to optimize the management and use of internal production inputs (i.e. on-farm resources) and to minimize the use of production inputs (i.e. off-farm resources), such as purchased fertilizers and pesticides, wherever and whenever feasible and practicable, to lower production costs, to avoid pollution of surface and groundwater, to reduce pesticide residues in food, to reduce a farmer's overall risk, and to increase both short- and long- term farm profitability.

The term is somewhat misleading and indeed unfortunate. For some it implied that farmers should starve their crops, let the weeds choke them out, and let insects clean up what was left. In fact, the term low-input referred to purchasing few off-farm inputs (usually fertilizers and pesticides), while increasing on-farm inputs (i.e. manures, cover crops, and especially management). Thus, a more accurate term would be different input or low external input rather than low-input (Norman, 1997).

2.4 Innovation concept

The Innovation Decision Process theory (Rogers, 1995) states that diffusion is a process that occurs over time and can be seen as having five distinct stages. The stages in the process are Knowledge, Persuasion, Decision, Implementation, and Confirmation. According to this theory, potential adopters of an innovation must learn about the innovation, be persuaded as to the merits of the innovation, decide to adopt, implement the innovation, and confirm (reject) the decision to adopt the innovation. This theory has been so widely cited in the instructional technology literature that Sachs (1993) stress about how to encourage the adoption of innovations or how to be better change agents is that there are five stages to the innovation adoption process. While Sachs correctly concludes that many other important theories of innovation diffusion area overlooked, the Innovation Decision Process theory remains among the most useful and well known.

The concept of innovation system provides many opportunities for learning about how a country's agricultural sector can make optimum use of new knowledge and to design new interventions that go beyond research and investments (World Bank, 2007). Therefore agricultural innovation system can be seen as the best approach to ensure food security in Africa. Innovation system thinking represents a significant change from the conventional linear approach to research and development. It provides analytical framework that explore complex relationships among heterogeneous agents, social and economic institutions, and endogenously determined technological and institutional opportunities. It demonstrates the importance of studying innovation as a process in which knowledge is accumulated and applied by heterogeneous agents, through complex interactions that are conditioned by social and economic institutions (Agwu *et al*., 2008).

Innovation is an interactive process involving various critical actors working in a given socioeconomic and cultural system to bring about improvements or advances in the production of goods and services. It is a dynamic process and it implies specific behaviors and performances, with obvious implications for outcomes. The concept of Innovation System has become an important framework for understanding technology development and diffusion in recent times (Nelson, 1993).

The framework stresses that innovation is neither research nor science and technology, but rather the application of knowledge (of all types) in production to achieve desired social or economic outcomes. This knowledge might be acquired through learning, research or experience, but until applied it cannot be considered innovation. While this knowledge can be brand new innovation often involves the reworking of the existing stock of knowledge, making new combinations or new uses (Edquist, 1997).

Agricultural innovations can be classified according to several parameters:

1. Genetic, mechanic and chemical innovations (private goods) and agronomic, managerial and animal husbandry innovations (public goods);

2. Individual innovations (individual adopter) and collective innovations (group of persons)

3. Continuous innovations, semi-continuous innovations, and discontinuous innovations with increasing demands for new skills, knowledge and even investments;

- Labor saving innovations and land saving innovations;
- Process innovations and product innovations;
- Endogenous and exogenous innovations (based on Sonnino 2009).

A slightly different categorization is suggested:

- Innovations embodied in capital goods or products ("shielded" and "non-shielded") and innovations not embodied;

Innovations according to impact:

- New products;
- Yield increasing innovations;
- Cost-reducing innovations;
- Innovations that enhance product quality.

Innovations according to form

- Mechanical, biological, chemical, biotechnical, and informational innovations

The innovation concept has been used by SWAC (2005) in a broad sense, integrating institutional, policy and organizational innovations. It includes:

i. Physical innovation (example: crop varieties, animal breeds, etc.);

ii. Institutional, social, organizational innovations (example: setting up producers' networks, better organization of input distribution networks, etc.);

iii. Innovations in terms of information and practices (example: cultural practices).

Characteristics of innovations

Rogers defines several intrinsic characteristics of innovations that influence an individual’s decision to adopt or reject an innovation (see table 2.2).

Table 2.2 Characteristics of innovations

Characteristic	Definition
Relative Advantage	How improved an innovation is over the previous generation?
Compatibility	The level of compatibility that an innovation has to be assimilated into an individual’s life.
Complexity or Simplicity	If the innovation is perceived as complicated or difficult to use, an individual is unlikely to adopt it.
Trialability	How easily an innovation may be experimented. If a user is able to test an innovation, the individual will be more likely to adopt it.
Observability	The extent that an innovation is visible to others. An innovation that is more visible will drive communication among the individual’s peers and personal networks and will in turn create more positive or negative reactions.

Perceived attributes

The Theory of Perceived Attributes (Rogers, 1995) states that potential adopter’s judge an innovation based on their perceptions in regard to five attributes of the innovation. These attributes are trial ability; observability; relative advantage; complexity; and compatibility. The theory holds that an innovation will experience an increased rate of diffusion if potential adopters perceive that the innovation: 1) can be tried on a limited basis before adoption; 2) offers observable results; 3) has an advantage relative to other innovations (or the status quo); 4) is not overly complex; and 5) is compatible with existing practices and values.

The Theory of Perceived Attributes has been used as the theoretical basis for several studies relevant to the field of instructional technology. Perceptions of compatibility, complexity, and relative advantage have been found to play a significant role in several IT-related adoption studies. Wyner (1974) and Holloway (1977) each found relative advantage and compatibility to be significant perceptions among potential adopters of instructional technology in high schools. Eads (1984) found compatibility was the most important attribute among students and school administrators.

2.5 Understanding resilience concept

Building on farm resilience, the generally accepted definition of resilience has been the capacity of a system to absorb disturbance and reorganize while undergoing change to still retain essentially the same function, structure, identity, and feedbacks (Walker and Salt, 2006). Resilience, therefore, is seen in this context as an emergent property – a relative attribute characterized by responses to disturbances which can only be assessed by looking at changes in a system over time. Qualities of resilience are evident in the notion of adaptive capacity, which is generally used to analyze how a system does, or does not, respond to endogenous and exogenous changes and is defined as "the ability of a system to adjust to change, moderate the effects, and cope with a disturbance" (Cutter *et al.*, 2008). A system characterized by diversity, potential for change, level of redundancy and by connectedness (feedbacks, flexibility) usually has better adaptive capacity (Folke, 2006).

However, the social-ecological resilience framework has been criticized for relying too heavily on deterministic and positivist natural science-based behavioral assumptions that may not necessarily be true for the resilience of human systems. Social scientists have felt particularly uncomfortable with notions of linearity and 'measurable' resilience responses assumed to be equally present in both social and ecological systems. As Adger (2000) highlighted, "it is not clear whether resilient ecosystems enable resilient communities". This was echoed by Davidson (2010) who argued that the social-ecological resilience approach “implies that in the absence of disturbances, systems will tend toward increasing complexity (but) several problems arise with the transfer of this model to social systems”, and that “the application of the (social-ecological) resilience framework to social systems will require improved articulation of the multiple relationships between complexity and disturbance in a less deterministic manner than is afforded by ecological systems”.

Thus, “while the structural complexity of both ecological and social systems can be conceived of in similar terms, the feedback processes associated with each are incomparable: social systems are unique in that the tendencies toward complexity, and the responses of individual organisms to those levels of complexity, are defined not solely by structural variables, but by agency” (Davidson, 2010).

The four nested adaptive cycles suggested in the deterministic ecosystems-oriented panache cycle may, thus, not occur in a linear fashion in human systems, but, as will be suggested in the analysis below, simultaneously with strongly overlapping and, at times, contradictory behaviors associated with less predictable human agency.

The result of these criticisms has been an emergent third strand of research focused on the resilience of human systems and communities, referred to as social resilience. This has been defined “as the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change” (Adger, 2000).

Folke (2006) particularly emphasized that social resilience is about the necessity of human systems to learn to manage by change and that it implies that “uncertainty and surprise is part of the game”. Social resilience can be both preventative (avoiding poor outcomes by developing coping strategies), or it may facilitate recovery after a traumatic event or catastrophe. Although understanding human–environment interactions continues to form a crucial component of these approaches, research on social resilience is often based on a ‘bottom-up’ approach predicated on understanding human drivers and indicators of resilience at community level, of which human–environment interactions are only one of many components. Rival (2009), therefore, argued that we need “to question resilience theorists for a lack of attention to power relations, politics, and culture”. As a result, social resilience research focuses more on the importance of politics, power and socio-economic, psychological and moral parameters than ‘traditional’ social-ecological resilience research (Adger, 2000; Cumming *et al*., 2005). Understanding the effects of anthropogenic processes such as globalization on community resilience, therefore, forms an important part of social resilience research.

There are obvious differences between ecologically informed notions of social-ecological resilience and those attempting to understand social resilience related, in particular, to issues of linearity/non-linearity. A key issue of non-linearity, for example, relates to the assumption that human systems can never return to their original state after disturbance (which ecosystems may be able to do) due to social learning processes and social memory. In human systems, therefore, adaptations can be both anticipatory and reactive, and depending on their degree of spontaneity they can be ad hoc or planned (Smit and Wandel, 2006). The notion of anticipation highlights that social learning implies human adjustment processes that propel the post-disturbance system to a different (sometimes ‘better’) state (Oudenhoven *et al*., 2010). This has crucial implications for the ‘management’ of community resilience, as the goal for adaptive capacity after a disturbance should often not be to attempt to reinstate the original state but to use learning processes and social memory as a basis for the creation of a qualitatively different more resilient community.

Social resilience is, therefore, about pre-emptive change which sees resilience as a desirable state, rather than simply a process to avoid disturbances. Resilience in this view is both an outcome, especially when linked to improved adaptive capacity of communities, and a process linked to dynamic changes over time associated with community learning and the willingness of communities to take responsibility and control of their development pathways (Chaskin, 2008).

While the ecological resilience literature has focused more on the ability of systems to return to function after a disturbance, social resilience is, therefore, about seeing disturbances as an opportunity for change and development.

This highlights that the notion of social resilience is essentially about understanding a ‘positive’ quality of a community under investigation, not dissimilar to the notion of ‘strong sustainability’. As a result, understanding social resilience is more closely associated with normative judgments about ‘good resilience’ and ‘bad vulnerability’ (Brand and Jax, 2007). The close association of resilience with the ability of a human system to absorb impacts/disturbance and to re-organize into a fully functioning (but qualitatively different) system is, therefore, closely associated with the notion of ‘positive’ quality, while community vulnerability usually describing exposure and sensitivity of a human system not able to cope with disturbances is generally associated with ‘negative’ quality (Adger, 2000). Although authors such as Gallopin (2007) have warned of unilinear assumptions underlying notions of resilience and vulnerability, many commentators are suggesting that resilience/vulnerability can be expressed as a spectrum. The extreme ends of the spectrum are more easily conceptualized, as few would contest that the complete disappearance of a community due to destruction of the livelihood base or a malign dictatorship are ‘bad’ development pathway associated with vulnerable communities. Normative judgments about social resilience are, therefore, rooted in measures of human survival.

Ecological resilience

The concept of resilience emerged primarily from ecology and has mainly been used to discuss ecosystems, albeit with two distinct meanings (Gunderson, 2000). The first definition concentrates on stability at a presumed point of equilibrium, resistance to a disturbance and the speed of return to the equilibrium point. The level of resistance to disturbance and the speed of return to the equilibrium are used to measure resilience (cf. Pimm, 1984; O’Neill *et al.*, 1986; Tilman and Downing, 1994). Holling (1996) refers to this kind of resilience as engineering resilience. The second definition of resilience emphasizes conditions far from any equilibrium state, where disturbances can flip a system into another regime of behavior or stability domain (Holling, 1973). In this definition, the measurement of resilience is the magnitude of disturbance that can be absorbed before the system changes the variables and processes that control behavior. This is called ecological resilience (Holling, 1996; Gunderson, 2000). Holling and his colleagues in the Resilience Alliance suggest that the latter definition is more useful based on numerous studies on ecosystem functioning (Holling, 1973, 1986, 2001; Gunderson, Holling and Light, 1995; Peterson, Allen and Holling, 1998; Gunderson, 2001; Carpenter *et al.*, 2001).

The adaptive cycle

The traditional view of ecosystem development has focused on two main functions of ecosystems: exploitation (r-phase) and conservation (K-phase). Exploitation is the rapid colonization of recently disturbed areas where fast consumption and reproduction is a winning strategy. Conservation is the slow accumulation and storage of energy and material where efficiency is the winning strategy. Ecological resilience is based on a complementary understanding of ecosystems dynamics. Holling proposed the adaptive cycle, as a heuristic model of ecosystem dynamics (see Figure 1), describing four phases of system development (e.g. Holling, 1986; Holling, 2001; Gunderson and Holling, 2002). Thus, they added two additional functions of ecosystems: release (Ω-phase) and reorganization (α-phase). In the release phase, the tightly bound accumulation of biomass and nutrients has become increasingly fragile until a release is suddenly triggered by a disturbance such as a forest fire or insect pest. In the reorganization phase, nutrients are reorganized so that they become available for the next phase of exploitation (Holling, 1986). The non-linear and complex character of ecosystems increases the importance of specifying the scale under observation. Also, the interaction across scales is critical (cf. Peterson *et al*., 1998). The concept of a 'panarchy' was coined to illustrate the nestedness of adaptive cycles and to provide a context for linking processes across scales (Holling, 2001; Gunderson and Holling, 2002). The model was originally developed for ecosystems, but is now applied to other systems as well (Gunderson and Holling, 2002). The adaptive cycle and panarchy will not be discussed further, except to conclude that social and natural systems are treated as equally important, and that panarchy theory has evolved into an exciting interdisciplinary field.

Resilience of social-ecological systems

To summarize, Holling's model views ecosystems as unpredictable, self-organizing, non-linear, multi-equilibrium systems. Living systems are also considered to be open (cf. Capra, 1996). In order for people to cope with change, uncertainty and surprise, and to maintain development options in face of change, management of resilience in the linked social-ecological system is necessary (cf. Resilience Alliance, 2003). Ecological resilience was briefly touched upon above and is defined as the capacity of a system to undergo disturbance while maintaining its key functions and controls (Holling 1973; Holling, 1996; Gunderson, 2000). Ecological resilience is measured by the magnitude of disturbance the system can tolerate and still persist (Holling, 1996). Yet, this thesis is concerned with the linked social-ecological system. Carpenter *et al*. (2001) provide a definition of social-ecological resilience, suggesting it reflects the following properties:

1. The amount of change the system can undergo and still remain within the same domain of attraction, that is, retain the same controls on structure and function (buffer capacity).

2. The degree to which the system is capable of self-organization (versus lack of organization or organization forced by external factors). Another expression for this would be the capacity for reorganization.

3. The degree to which the system can build the capacity to learn and adapt. Adaptive capacity is a feature of resilience that reflects the learning and appropriate action in response to disturbance (Gunderson, 2000).

This definition is used as a point of departure in papers III and IV. Folke, Colding and Berkes (2003) suggest that in order to build social-ecological resilience four additional aspects are crucial: 1. learning to live with change and uncertainty 2. nurturing diversity for reorganization and renewal 3. creating opportunity for self-organization 4. combining different types of knowledge.

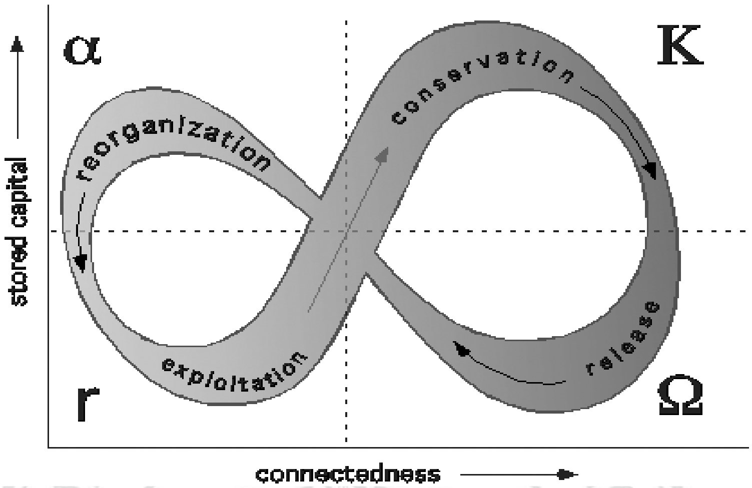

Figure 2 The adaptive cycle: Connectedness and brittleness increases in the K-phase. Stored capital is released in the Ω-phase and reorganized
Source: Adapted from Holling and Gunderson, (2002)

Social-ecological resilience in farming systems

Literature about farming systems (Dent and McGregor, 1994) has much in common with resilience theory. Farms can be considered as learning systems in constant co-evolution with their environment. Conway (1987) describes agro-ecosystems as self-organizing, self-regulating systems. In this sense, sustainable development of farms is a measure of the persistence of individual farmers or farm families as learners and co-evolvers who are continuously trying to improve the quality of their ecological relationships (Sriskandarajah *et al*., 1991). Bawden (1991) argues for a shift in thinking in agriculture from thinking about productivity to thinking about persistence. There are a number of concepts that are also dealt with in these fields that pertain to resilience theory, e.g. adaptation, diversity, vulnerability, risk management and change, to name but a few. In the following discussion on farm resilience I try to show how farming system research, agro-ecology and resilience theory can be matched.

Resilience of what to what farmers' perspectives

As agricultural research and development generally aim to improve systems, success depends upon being clear about: a) what constitutes an improvement; and b) exactly which system is to be improved (Spedding, 1979). This statement is similar to assertions regarding resilience, namely that one must specify which system configuration and to what changes a system's resilience should be assessed, i.e. the resilience of what to what. The socially preferred system state, i.e. the desired system state, is a matter of interpretation and interchange between ecosystems and humans. Therefore, a relevant point of departure in the case of agriculture and changes in the realities of farmers is the perspective of farmers. Understanding farmer decisions is a prerequisite for progress in agricultural development (Collinson, 2000). Participation of farmers in research that covers topics like this thesis is useful for a number of reasons. First, farmers have knowledge vital for the management of agro-ecosystems (Scoones and Thompson, 1994). Second, if, e.g., decision makers, researchers and farmers cooperate, different kinds of knowledge are used and efficiency is enhanced. Third, if local people are influenced by research, democratic principles demand that local natural resource managers are involved in decision making. This could increase acceptance and implementation of difficult decisions on resource use to a higher degree than at present. Consequently, involving the resource users is not only a matter for policy, but also for research. This leads on to the next section, which deals with the research methodology.

2.6 Knowledge Management

Definition of knowledge management

KM is managing the corporation's knowledge through a systematically and organizationally specified process for acquiring, organizing, sustaining, applying, sharing and renewing both the tacit and explicit knowledge of employees to enhance organizational performance and create value (Allee, 1997).

Knowledge is a dynamic combination of experience, expert insight, values and contextual information. It can be intangible, personal, elusive, and immeasurable (Gorelick, 2005). Knowledge constitutes a foundation for evaluating new experiences and information and is continually shaped through new experiences. Knowledge has two very distinct aspects; the easily communicated and recorded or explicit knowledge and tacit knowledge which is embedded in the minds of individuals and is not so easily documented (Nanoka and Takeuchi, 1995).

Explicit and Tacit Knowledge

Concepts of "explicit" and "tacit" knowledge are meant to get at the fact that knowledge is a deeply rooted human process that lives within the private world of the individual and cannot simply be reduced to information processing and software automation. At the same time, the human process lives in the public domain of communication and language, culture and representation that generates knowledge artifacts. These artifacts can be powerfully enhanced through software automation.

Explicit knowledge can be recorded digitally in documents, records, patents and other intellectual property artifacts. Explicit knowledge is representational and can live and be manipulated within the digital domain. Converting data-to-information and information-to-knowledge describes a value continuum of explicit knowledge. The tools and business processes of KM are intended to enhance this continuum of value.

Tacit knowledge is made up of best practices, experience, wisdom and un recordable intellectual property that live within individuals and teams. Since tacit knowledge exists within minds, it cannot be reduced to the digital domain as a material asset, or be manipulated directly. However, it expresses in the social realm as the response ability of individuals (productivity, innovation and initiative), and teamwork (communication, coordination and collaboration).

The field of Knowledge Management (KM) was established as a discipline in 1991. An important KM paper addressing what was earlier referred to as organizational knowledge was written by Ikujiro Nonaka who made the early connection between tacit knowledge (experiential) and explicit knowledge (articulated, codified, and stored) with knowledge conversion, the interaction of these forms of knowledge particularly to enhance an organization’s efficiency, productivity and profitability. KM places a strong emphasis on corporate knowledge culture. Nonaka used the following model to demonstrate:

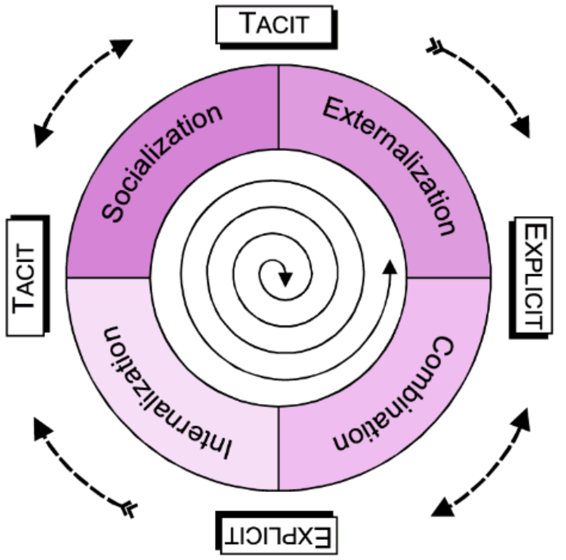

Figure 3 Knowledge conversions
Source: Nokata, 1991.

Livelihood asset is the part of knowledge management. The members of a household combine their capabilities, skills and knowledge with the different resources at their disposal to create activities that will enable them to achieve the best possible livelihood for themselves and the household as a whole. Everything that goes towards creating that livelihood can be thought of as a livelihood asset. These assets can be divided into the five different “types” shown in Figure 4 This division into five types of livelihood assets is not definitive. It is just one way of dividing up livelihood assets. Other ways may be developed depending on local circumstances. What is important here is that these are all elements of livelihoods that influence households directly or are potentially controlled by them.

This asset pentagon can provide a useful starting point for household livelihood analysis, as it encourages investigators to take into account all the different kinds of assets and resources that are likely to play a role in household livelihoods. In the past, development workers often tended to focus very much on the physical capital (by providing new technology and infrastructure), the financial capital (by providing credit) and the human capital (by providing skills and training). But very often people's access to natural capital and the key role of the social capital of households has not been properly taken into account. Using this pentagon as a guide can help investigators to get a more complete picture of the household and its livelihood assets.

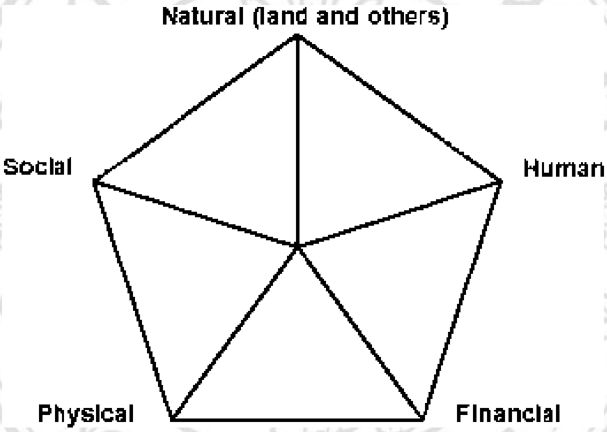

Figure 4 Explain in radar diagram

Source: FAO corporate documents repository.

Livelihood assets can be classified into five groups;

1) Natural capital - natural resources from which resources and services for livelihoods are derived (e.g. vegetation, land, water).

2) Social capital - social organizations that facilitate or constrain cooperative enterprises, inter-household relationships, formal/informal networks.

3) Human capital - education, knowledge, health that enable people to solve their own problems and to pursue different livelihood strategies.

4) Physical capital - infrastructure, equipment, property to support livelihoods (affordable transport; shelter; water supply, sanitation; energy).

5) Financial capital - financial resources that people use to achieve their livelihood objectives (e.g. access to credit, loans, savings and remittances).

The interaction of livelihood assets with policies, institutions, and processes and with livelihood strategies (combinations of farming and non-farming activities, for example, migration, off-farm work, abandoning farming for urban employment, farming diversification or, intensification) influence people's livelihoods.

2.7 Related Studies

Nguyen, C. (2003) found that the conventional tea systems was different from organic tea systems in farm practices, i.e., manuring, crop protection. Synthetic chemical fertilizers were applied for conventional tea whereas organic fertilizers, compost were applied for organic tea. In comparison with yield and gross margin, it found average yield of organic fresh tea was lower 136.5 kg ha^{-1} than that of conventional tea, but as compensated, its price was as one a half time of conventional tea price when tea farmers sold fresh tea, and two times when they sold a processed tea to Hanoi organic Organization. As a result its net margin was three and half time much more than that of conventional tea system. Processing and marketing practices were differed for each other between two systems, i.e., most conventional tea was processed in tea factories while organic tea was only processed in family-scaled unit.

Smith and McDonald (1998) in Praneetvatakul *et al*. (2001) stated that in the agricultural sector, goals for sustainability generally include the maintenance or enhancement of the natural environment, provision of human food needs, economic viability, and social welfare. Inevitably, the ability of a community to maintain sustainable agricultural activities overtime depends on the practices at the present time. In order words, for agricultural activities to be sustained, they should be technically feasible, economically viable, socially acceptable, and environmentally sound at any point in time.

Ratih (2009) assessed the household level with nine farm-level sustainability indicators selected: amount of organic input used, soil fertility, water saving, input self-sufficiency, farmers' awareness, employment generation, land productivity, income stability, and profitability. Sustainability indicator analysis (SIA) with equal weight of indicators and un-equal weight obtained from Analytic hierarchy process (AHP) method as well as AMOEBA diagram are used to present the overall sustainability of integrated coffee-based farming systems.

Bellini (2001) assessed the ecological dimensions of sustainability which called agri-environmental on farm management practices through farm structure survey conducted in 1998. The indicators under the agri-environmental that have been used are soil and land management, irrigation technology, nutrient management, and pest management.

Anonym (1997) in the "farm Management 500 project Bench marketing for Sustainability Indicators" stated the there are two types of sustainability indicators. First, regional or national indicators covered net farm income, productivity, food contamination level, water use efficiency, nutrient balance, term of trade, farm planning capacity, farmer education level, as the higher value sub indicators. Second, on-farm indicators, which included disposable income, debt to income ratio, soil erosion, return of assets, return of equity, as the higher value sub indicators.

Rasul and Thapa (2004) used five indicators in assessing the ecological sustainability, namely land-used pattern, cropping pattern, soil fertility management, pest and disease management, and soil fertility status. In order to assess the economic viability in term of economic sustainability, they used land productivity, yield stability, and profitability. And the social acceptability was assessed in terms of input self-sufficiency, equity, food security, and the risk and uncertainty in crop cultivation.

Regarding to the sustainable indicators which are typical and different between levels, the series of index as indicators for sustainability assessment at farm level are also discussed by Rigby *et al.* (2001). In their paper, they focused specifically on the development of an indicator of sustainable agricultural practices at the farm level for a sample of 237 UK horticultural producers. As a report based on Taylor *et al*. (1993), in Malaysia there were five indicators constructed to measure the sustainability of agricultural practices at farm level, such as: insect control, disease control, weed control, soil fertility maintenance, and soil erosion control. In other research, Gomez-Limon (2006) constructed a farm level indicators of sustainability used six aspects, those are yield, profit, frequency of crop failure, soil depth, organic carbon, and permanent ground cover.

In addition, Kammerbauer *et al*. (2001) studied the indicators development in tropical mountainous regions and some implications for natural resource policy designs as an integrated community case study. They identified and assessed indicators of landscape mosaic, soil fertility, water resources, as well as production systems and extractive activities, economic and social performance, and institutions, both of which were produced by the local population as well as by the researchers at the community level.

Jintana and Akimi (2009) clarified the sustainability of organic farming in comparison with other production systems through an examination of household income, and environmental and social benefits, and identify the level of environmental and social impacts under different farming systems by socio environmental index and total product. This situation demonstrates that organic farming had the sustainable manner due to the highest profit with higher prices contributing to the highest income, and the lowest negative impacts for environmental and social sectors in comparison with other production system in Chiang Mai.

Temesgen (2008) this study employed the Hickman probit model to analyze the two- step process of adaptation to climate change, which initially requires farmer's perception that climate is changing and then responding to changes through adaptation. The analysis of perception of farmers to climate change revealed that age of the household head; wealth, information on climate change, social capital and agro ecological settings have significant impact on the perception of farmers to climate change. Moreover, the analysis of factors affecting adaptation to climate change indicates that education of the head of the household, household size, gender of the head of the household being male, livestock ownership and extension on crop and livestock production, availability of credit and temperature have positive and significant impact on adaptation to climate change. Additionally, the main barriers to adaptation identified include lack of information on adaptation methods and financial constraints to using the methods.

Li and Rabina (2010) frequently unknown climate change increases the risk of agriculture, more attention have been paid to agricultural system itself in the research field, but few has been attached to the perspective of social dimension. Based on the research on Yangtze River Basin of China, the paper has adopted vulnerability theory including the exposure of agricultural ecosystem, farmers' sensitivity to exposure and adaptive capacity to climate risk, to explain farmer's adaptation to climate risk. It concludes that climate change has increased climate risk in agriculture and the uncertainty of agricultural production. Confronting climate risk in agriculture, different farming bodies have shown different farm and off-farm/non-farm adaptations in pre-risk, during risk and post-risk, which has reduced their short-term vulnerability. Household life cycle, pressure, institution, available resources and technologies are the key influential factors. From the adaptation in long term, it still requires external support and more investment including agricultural insurance system, village-level information and technology dissemination mechanism.

Umma *et al.* (2012) this study was conducted with 718 farmers of owner, owner-cum-tenant and tenant farmers of irrigated and non-irrigated villages at 14 upazila (sub-district) in two severe drought-prone districts of northwestern Bangladesh through a semi-structured questionnaire. It assessed farmer's perception and awareness, impacts and adaptation measures of farmers towards drought. The results revealed that farmers in both areas perceived a changed climate in recent years. They not only identified that drought is the most prevalent disaster in the study area because of rainfall and temperature variation, but also groundwater depletion, lack of canal and river dragging, increased population, deforestation, etc. accelerate drought in this area. As a consequence of drought, agriculture as well as farmers' social life and health are threatened the most. To cope with drought, farmers have been adapting various practices mainly through agronomic management, crop intensification, water resource exploitation, etc. Among different farmer groups in both irrigated and non-irrigated areas, it has been seen that owner farmers have more capacity to adopt new technology than owner-cum-tenant and tenant farmer. In conclusion, this study recommended that interrelationship among different stakeholders, effective early warning system and improved water conservation systems are essential to sustain farmers livelihood in the event of drought.

Yoosuf (2007) studied on knowledge management and knowledge-based marketing by two separate qualitative research studies are designed to gain an insight into the practice of knowledge management and marketing in the engineering and biotechnology industries. The findings show that the engineering industry is practicing knowledge management to varying degrees. The biotechnology industry clearly differentiates between data, information and knowledge. With the new knowledge gained, the biotechnology industry (a rapidly growing knowledge-intensive industry, according to Donn Szaro) is able to innovate and market new products and services. A Knowledge Management System (KMS) model has been used to show how the various components within the KMS are coordinated and integrated to best achieve organizational objectives in the engineering and biotechnology industries. The KMS model is also used to show how customer-focused organizations use knowledge to market innovative products and services.

Kaj U. Koskinen (2003) studied evaluation of tacit knowledge utilization in work units. This article introduces a model with the help of which the management of businesses can evaluate what kind of a role tacit knowledge plays in their organizations. At the beginning of the article basic elements from which an individual's competence is derived are described. After that the structure of the model is discussed. Four different systems, namely memory, communication, motivational, and situational systems, which all include numerous factors that affect tacit knowledge utilization in organizations, are illustrated. The article ends with the introduction of the model and a brief speculation about its application possibilities in different work units.

Agricultural development and the turning point, the case of Mr. Boonthong Jantaki's family

This is the interviewed case from Mr. Boonthong Jantaki's family in Samoeang district and this part also shown in chapter 4 transformations of farmers in Samoeang district.

1986 was the year Mr. Boonthong started his family life. Shortly after his marriage, with the thought to build a wealth for his family, he bought a piece of land at Ban Mae Jae in Mae Chaem District in a cool climate area suitable for strawberry plant propagation. In rainy season, he prepared strawberry seedlings for selling at 0.75 - 1.00 baht per plant and if the purchase order came from Chiang Rai, he was able to fetch 1.50 baht per plant and just paid the transportation cost at 0.50 baht per plant. His income depended on how much he could propagate the seedlings and the maximum he used to get was 30.000 plants. The successful propagation of strawberry seedlings requires not only the mildly cold climate and plentiful watering but also many kinds of fungicides to ensure the plant vitality. Mr. Boonthong had to spent high cost every propagation season for substantial use of fungicides to minimize the seedling damages. After the strawberry seedlings were removed, chrysanthemum would be planted as the following crop in the same and total land for flowers which would be dried for making tea. Similarly, the successful chrysanthemum flowers production needs heavy fungicides for plant stem and flower vigor. After the chrysanthemum plants were harvested for flowers, then came again the strawberry season. Fungicides were thus repeatedly applied in the same land all year round. Mr. Boonthong, however, had a paddy land in his home village at Samoeng District.

In 1988, Mr. Boonthong rented a piece of land in Tambon Bo Kaeo in Samoeng District which is a highland area with favorable climate for strawberry planting. As this land was 30 kilometers away from his home and the travel was quite difficult and costly, he decided to build a cottage nearby the strawberry plots and made it his temporary home.

Cultivation of strawberry needs very intensive care from seeding to harvesting stage. Old leaves must be removed, weeds must be eliminated, and strawberry diseases and insect pests must be controlled. Growers have to use a great variety of agrochemicals for plant protection. Every other 2 or 3 days' morning, Mr. Boonthong had to spray fungicides, and other chemicals to control strawberry crown rots and fruit rots. When fruits were mature, he had to get up as early as 4 or 5 o'clock in the morning to harvest the fruits and select the fruits having the size or grade demanded by the manufacturer and transport the selected fruits to the manufacturing plant before 8 o'clock in the morning. These were his routines during the six-month strawberry fruit production season, entitling him not able to avoid the contact with agrochemicals. However, his family was capable of making more than hundred thousand baht in some years from strawberry.

"One year, we supplied strawberry to the manufacturing plant and made more than one hundred thousand baht, we used to get only seventy or eighty thousand baht previously. But we had never had the actual feel of that enormous money. This is because we borrowed the input-in-kind either fertilizers or agrochemicals from the manufacturer who would deduct the money from the total payment for strawberry purchase to settle our borrowing. What was left after we paid for our farm laborers was so little."

1994 was the year Mr. Boonthong began to suffer health problems due to his intense contact to agrochemicals and his intense labor to complete necessary works to prevent strawberry plants and fruits from rot damage especially during the time when abnormal raining may result in a complete loss overnight of the production investment. Worst of all, he experienced distressing vomiting, and the loss of appetite, weight, and energy severe enough to prevent him from active works or even movement, as well as the accompanying increase in medical expenses. During his struggling to find the way out episode, Mr. Boonthong happened to meet an NGO worker who came to promote the concept of organic agriculture and he got very interested in this alternative after thinking that he could never go back to lead the previous way of life.

In 1995, Mr. Boonthong and his wife, Yupin, began to transform the family's production system from chemical input dependent monoculture to organic and integrated farming on his father's unutilized land and on a new land he purchased with a borrowed fund which was successfully repaid in a year. This means Mr. Boonthong had two pieces of land, not too far from home and in suitable environment, to start with the organic farming. His other older pieces of land had been in the process of gradual transformation into diversified farming fields anwithout the use of chemicals since 1995.