CHAPTER 1

Introduction

This chapter introduces the world's agricultural situation which including the farming population around the world, agricultural development and organic agricultural situation at this time improving and to sustaining the environment. This chapter introduces about appropriate technology to improve agricultural production and to sustain the surroundings. Moreover, this research introduces about situation of Thai people education in rural area. After that, it presents the theme of this research that demonstrates the problem of knowledge transfer from academic research and appropriate technology from sustainable development projects in Thailand. Additionally, the idea is to solve this problem. Subsequently, this research presents about the aims and methodology, which completed with this study, and present the expected outcome that this research expects to acquire form this research.

1.1 The world's agricultural situation

The population in this world increases double to approximately seven billion people, which the world's population is more than three billion people live in rural areas. The world's population is forecast over the next four decades to increase by two billion people to surpass nine billion people by 2050. Lately, Food and Agriculture Organization (FAO) assessments specify that to meet the expected demand, global agricultural production will have to grow by sixty percent from its 2005–2007 levels.

The agriculture especially in developing countries can be an important influence of economic growth and also provide an important in contradiction of global economic and financial disorder which the agriculture is more effectively role than other divisions. The agronomic population is described as all people reliant on farming, fishing, stalking and forestry for their livings. In excess of a third of the world's population depends on farming which the largest percentage is in Asia for its income. Furthermore, however agriculture's generally impact to output has failed over the last two decades, the productivity of agricultures per worker has increased. The world's farming production has developed on average between two and four percent per year around the last fifty years, whereas the cultivated area which is permanent agricultural land and arable farming area has increased by only one percent yearly.

The food production that increases more than forty percent has come from irrigated regions. The tendencies in food production per capita have been typically positive across most areas over recent decades. The agricultural production on average of growth rates in Africa has improved at slightly less than one percent per year which compared with nearly two percent in developing countries generally.

The global crop invention has increased threefold in the past 50 years which has been driven mainly by high yields per unit of land and crop growth resulting from multiple cropping and/or shortening of unplanted periods. The expansion of arable area allocated to crops which has presented a less important part in production growths. These trends are not unchanging across areas for example; the growth mostly in wheat and rice manufacture in developing countries in the land-scarce areas of Asia and Northern Africa has been the result of improvements in yield. However, growth of harvested land is following the rapid manufacture growth of maize in Latin America and the Caribbean and in sub-Saharan Africa. The yield development contributed only one-third of the increase in crop production in the last area. The global arable space increased by 67 million ha over the past half century.

The environmental intensity of main grain supplies versus the environmental distribution of demand recommends that trade will continue to be important in accomplishing grain requirements, for wheat and maize particularly. The most agricultural production located in the temperate regions of developed countries which increasing supplies in developing economies have improved the dependence on exports of these countries.

Rice is the main essential for more than half the world's population where Asia is representative the largest manufacturing and consuming area. The rice has also become an important essential throughout Africa in recent years.

The agricultural production should be equal to consumption of the barring changes in stocks at the worldwide level. However, the opposing raising rates can be observed for individual countries and nation groups which depending on changes in their net agricultural commerce positions. Generally, the growing rates of production in most developing areas have been slightly smaller than those of demand because these countries' agricultural importations have developed faster than their exportations. Consequently regularly eroding their traditional excesses in agricultural commerce (excluding forestry and fishery goods).

Usually, the developing countries have been traders of products from moderate agriculture especially cereals wheat and coarse grains and exporters of rice. The trading developing countries have been increasing their agricultural product exports in recent decades. China and India have joined the traditional exporters of Southern America, such as Argentina and Brazil, and India and China have become net exporters of other cereals. Moreover, the rice exporters of Asia is including Thailand.

The agriculture that is including forest, crops, fisheries, aquaculture and livestock is the main human activity reliable for environmental resource management at the rural and regional levels. The world's land is used for crops and grassy pastures in thirty percent, and seventy percent of all existing freshwater is pointed towards irrigation to produce the food that communities and livestock need for a steady food supply. The consequences of such wide-ranging utilization of land and water resources are increasingly threatening surroundings.

The undesirable impacts on soils, water and air have a negative effect on agricultural product manufacture and human well-being. The soil salinity and aquifer reduction are increased including land degradation reduced achievable yields accordingly situating at risk farmers' capability in order to bond manufacture gaps and improve food safety. The unsustainable and deforestation forest management cause ecosystem degradation, with negative impacts on the overall potential for a varied range of ecosystem facilities. The nitrogen loads and contamination in aquaculture ponds or genetic pollution of marine capitals reduce flexibility of the underlying environmental systems without which aquaculture and marine capitals cannot function.

Although agriculture will continue to be a main user of water and land, it will need to pursue new methods of maintaining these resources to stay feasible, and to minimize negative effects on human well-being and ecosystems. The sufficient water and food ensure for all achieving sustainable rural development centers on renewed stewardship for the responsible management of environmental resources and then on a fully sustainable agriculture system.

A sizeable reservoir of genetic and species diversity requires to be supported and sustainably used to achieve sustainable growths in productivity, and provide a better ecological basis for agriculture. The crop rotations, multiple cropping, alley farming and the usage of several diversities of a single crop have been revealed to have beneficial impacts on crop performance, pest and disease control, nutrient availability, and water management. The bio-diversity will help preserve and rehabilitate productive ecosystems to reserve future generations with plentiful agriculture and food. Furthermore, continuing methods to enlarge protected regions will also perform a major role.

Agricultural manufacture systems need stewardship of their fundamental ecosystems and respect of the environmental supply boundaries within which they work. However, in recent decades, population growths and socio-economic pressures on the genetic resources, water and land that reinforce the provision of food and other valuable environmental services are reason for concern which given that food manufacture should roughly double by 2050 in order to fulfill the expected global population of 9 billion people.

Agriculture previously uses two-thirds of the freshwater resources extracted for human usage, with irrigated crops affording about forty percent of the total cereal harvest. The additional land appropriate for suitable production is unusual, while the pressure to manufacture more food on bordering areas can lead to poverty and degradation.

The environmental agricultural indicators are quantitative tools that help quantify and measure the position of trends in the ecological performance of agriculture which facilitating the identification of useful management solutions and procedure measures for avoiding potential destruction, including water and soil degradation, loss of biodiversity and air pollution.

The agricultural yield profits have invented from developed harvesting techniques, irrigation and fertilization which obtained in experimental fields. Instead, the average agricultural yields of some developing countries are estimated much lower than their prospective and failing to reach thirty percent in some cases. The low agricultural productivity can be the consequence of deprived material and market arrangement, and incorrect encouragements. Furthermore, food availability can be value-added by decreasing wastage and post-harvest damages. However, the strengthening of agricultural production can be related with significant negative environmental outcomes which including groundwater contamination, a damage in biodiversity and soil destruction. The sustainable consumption of limited resource involves considerable enhancements in the environmental management, water, land usage, and contributions. Consequently, continuous the enabling environmental reserves are essential in improved developing and transferring appropriate technologies to decrease losses in biodiversity, post-harvest losses and limit carbon releases from farming. The farmers are probable to implement appropriate technologies for well-functioning input and output markets and risk management tools as long as there are comprehensive incentives to improve infrastructure, and better finance.

The information of agriculture presented in this study are from a selection of essential indicators originally developed by Organization for Economic Cooperation and Development (OECD) and Eurostat for their member countries, and recently extended by Food and Agriculture Organization (FAO) to achieve worldwide coverage. They emphasize critical tendencies that can help to identify solutions for more sustainable production systems. Generally, the indicators demonstrate different trends between developed and developing countries; for instance, the agricultural region is decreasing in most developed countries but increasing in several developing countries.

The indicators display considerable growth of irrigated agricultural regions, especially in developing countries, with the agriculture area using the most water in most areas, over the last decade. Fertilizer consumption is rising worldwide, while fertilizer consumption is much lower in Africa than in other areas. Moreover, over the last twenty years, the portion of region protected for eco-friendly reasons has increased significantly in several countries. The occurrence of organic agriculture has also increased constantly; while its contribution remains minor in developing countries, organic agriculture presently characterizes an important portion in several developed countries.

Organic agriculture is a manufacture management system that aims to endorse and improve ecology health, including the biological activity of soil and biological systems. The organic farming is based on diminishing the usage of external contributions, and characterizes a considered effort to make the best usage of local environmental resources. The techniques are selected to reduce pollution of water, soil and air. Organic agriculture includes a variety of animal, plant and land management methods, circumscribed by a set of limits and rules which are usually obligatory by inspection and certification arrangements. The mineral fertilizers, synthetic pesticides, synthetic preservers, genetically modified organisms (GMOs), pharmaceuticals, irradiation and sewage sludge are forbidden in all organic standards.

The agricultural land area under organic management system has been progressively increasing global for several decades, reaching 37.2 million hectare in 2011, up from 11 million hectare in 1999. An additional 32.5 million hectare is qualified as non-agriculture organic areas, mostly for the group of wild crops and beekeeping. Currently, 1.8 million manufacturers in 162 countries produce organic products, including, livestock, crops, fish and wild-harvested yields. Most manufacture in developing countries is export-oriented, delivering new income chances for smallholders.

The total value of organic beverages and food sold in 2011 was nearly US$63 billion, some US$4 billion greater than in 2010. The organic market has developed considerably since 2002 and has continued to produce, despite the worldwide economic slowdown. While Northern America and Europe account for 90 percent of organic sales, organic markets are also growing in developing countries, particularly in Asia.

Many countries have strategies for developing organic agriculture, and 86 countries currently have organic principles. Countries established targets for the region's growth which allocating resources to recompense agriculturalists during, and sometimes after, the conversion period.

The Codex Alimentarius Commission defines the general principles and requirements for organic food at the international level. The Plant Production Guidelines were accepted in 1999, and the Animal Production Guidelines in 2011. The list of controlled substances has been regularly updated since 2005. Codex is presently increasing to include organic aquaculture and seaweed manufacture. The increasing interest in organic livestock, crop, fish and forest products is essentially driven by food-quality concerns and health, although the crucial aim of organic production is to certify that processing methods and food manufacture respect the ecosystem.

Organic applies that encourage nutrient cycling and soil biological activity include operating crop rotations and strip cropping; organic fertilization and green manuring (animal manure, compost, crop residues), minimum tillage or zero the preparation of land for growing crops and avoidance of herbicide and pesticide usage. The organic agriculture increases significantly the density of root symbioses, beneficial invertebrates, earthworms, and other micro-organisms (fungi, bacteria). Appropriately managed organic agriculture diminishes or eliminates water pollution and assists conserve soil and water on the farm.

Therefore, organic agriculture has established to be a comparatively inexpensive and practical selection to address climate variability. This selection is based on scientific evidence for certain areas and widespread, however not scientifically documented, operational field application. Reports reliably show that organic agricultural systems have improved ability to endure droughts and floods and maintain high flexibility in the face of unpredictable effects of climate change.

1.2 The agricultural situation in Thailand

The population in Thailand was approximately at 63.5 million people in 2007, enclosed agricultural area 24.8 million people (about 39 percent of the total Thailand's population). The total region is estimated 514,000 square kilometers. Forty-one percent of the total land region is used for agricultural purposes, thirty-one percent is forestland and twenty-eight percent is unorganized area. Thailand is mainly an agricultural country. About 9 percent of the uncultured domestic product is resulting from agricultural region. The agricultural products in Thailand have not only been manufactured for their own consumption but also being a main source of revenue from exporting. The worth of agricultural trades is growing every year and a main source of export earnings. Presently agricultural trades establish about 25 percent of the total export worth. Thai government is endeavoring to improve agricultural productivity by increasing efficiency; it is vital to raise profits and improves the living standard of the Thai's people. Consequently Thai farmers and the associated agencies would have up to the present time and accurate agricultural statistics and information, knowledge form appropriate technology in order to plan strategy, and approach for increased productivity. Lately, livestock products and fisheries products become more important source of export producing. Agriculture in Thailand has developed at rates of over 4% a year initially, later slowing to 2% a year, more than the population over the previous 50 years. This has occurred within an economy that has become more urbanized and industrialized.

The Thai division is a suitable example of managing a transition from a situation in which it was feasible for agriculture to produce by placing underused factors of manufacture to work, with only limited improvements in productivity. Thai agriculture currently crops greatly competitive exports, based on increasingly specialized and expanded farming. Generally, agricultural development has contributed to better food security and nutrition and falling rural poverty.

The initial agricultural growth through economic transition, the new areas were began for farming, enabled by the existence of a forest frontier where squatting was allowed from the 1960s to the early 1980s. This fascinated growing labor to produce more of the major staples for both the domestic marketplace and export which is rice and teak in the first place. The agriculture was the major driver of the economy that is more than 70% of the active population, among them the enormous majority of the poor was employed in the agricultural region in 1980.

The agriculture was improved productivity at a time of economic transition then began to transform, as Thailand faced economic growth rapidly led by industrial. Labor started to leave agriculture then attracted by jobs in industrial, urban service industries and the rural non-farm economy. It was becoming harder to accelerate new land at the same time. Moreover, the agricultural development slowed, but production of land and labor increased remarkably. The greater application of inputs and better diversities usage led to increasing crops. Consequently, some Thai agricultural exports are competitive that they define the lowest cost manufacture in the world, for instance cassava from covering northeast area and once the landlocked. The agricultural households have increasingly expanded their income sources, and some have developed ever more specialized in better value products vended into more advanced marketing chains.

The poverty has fallen throughout Thailand since 1960 that rates in rural areas have also fallen noticeably. It is more than 60% of the rural population lived in poverty in the early 1960s and the number was at a little more than 10% in the early 2000s. Improvements possibly derived initially from growing farm earnings and payments from migrants and subsequently from rural non-farm jobs.

By agricultural growth, the number of farming households affected by food poverty decreased from 2.55 million to 418,000 and it nearly disappeared from urban regions from 1988 to 2007. Consequently, child malnourishment has also declined that occurrence of underweight young children dropped from 17% in 1987 to 7% in 2006 that of inhibiting fell from 25% to 16%.

Specialization and modification among farmers have been probable partly because of the appearance of higher-value markets together with the country’s economic growth. Technically innovative supposed ‘professional farmers’ characterized 19.5% of Thai farmers in 2004.

The several agroindustry businesses were established with European and Chinese investments, but following the government developed public and semi-public agroindustry businesses. These significant independence and limited responsibility to their line organizations that they were expected to produce profit. Agroindustry has been contributory in increasing exports, as well as in motivating growth of greater value produce in domestic markets. The rural non-farm economy has developed to the point where it offers around half of all rural occupations and many of these are related to growing agriculture.

By universal primary education nearly achieved, additional investments in post-primary education have contributed to agricultural efficiency growth. The agricultural academic research has also performed a great role. The acceptance of agricultural research productivities has increased, especially improved modern rice, rubber, soybean, maize and cassava varieties.

1.3 Organic agriculture in Thailand

In Thailand, as a developing country, production is comparatively high-priced, in order to be competitive that it will be vital to board along new pathways in regard to expansion, quality production such as in organic agriculture.

The "green revolution" carried innovations in the agriculture of crops from the middle of the 20th century. Partially, introducing new high-yielding varieties, artificial fertilizers, pesticides and irrigation plants could reach a considerable growth in yields. Towards afford the increased costs for external inputs agriculturalists left their families for months to work off agricultural areas.

The many farmers in Thailand had to start loans to purchase pesticides and fertilizers. So a significance of failure of crops or even shortfall that the loans could not be repaid, resulting in indebtedness of many Thai agriculturalists (Donner, 1989) which still presents a main problem at this time. Additionally, the requirement to get money and the declining opportunities to find job in rural areas forces rural people from the countryside to the cities.

The agriculture can cause ecological problems because it changes the environmental ecosystem in several ways. Potential ecological effects including (e.g. El Hage Scialabba and Hattam 2002) such as effects on water that excesses of nitrogen and phosphorus and residues of pesticides in ground water and surface water; for effects on air that particulate substance, including ammonium off-gazing and ammonia from animal and dust from fields, odor from farming waste, all contributing to air pollution. The higher temperature of local agricultural fields compared to forest. Additionally, effects on soil that is depletion of minerals in the soil, soil erosion, soil salination and loss of organic matter. Effects on living organisms which is damaging effects of insecticides, herbicides, fungicides, and other agrochemicals, that cause reduction of high biodiversity. Moreover overall ecological effects such as the involvement towards the global climate can be considered as well as economic implications and the community.

The rapid growth in Thailand over the previous thirty years as the Thailand Environment Monitor 2004 (World Bank 2004) reports was accompanied by degradation of environmental resources and significant pollution in rural communities. Among other causes of pollution, farming run-off has increasingly polluted seaside, ground and surface water. Woodland covering was halved from 53 % in 1961 to 28 % in 1989, when a classification ban was compulsory. This problem is particularly serious in the Northeast, where woodland cover decreased by approximately 60 % in the late 80s and early 90s. The four fifth of the total region in Thailand soils are degraded, following FAO estimations that half of the region is even very rigorously degraded (FAO 2003) by chemical deterioration and water corrosion caused by cultivation and deforestation. There is also need for accomplishment and it is recommendable to "integrate biodiversity preservation into economic arrangement and into production sceneries" (World Bank 2004) in regard to biodiversity preservation.

Thailand Environmental Monitor (World Bank 2004) reports an increasing environmental awareness and environmental problems require concentration, not least because of their association with poverty. Awareness of the relation between social problems and environmental degraded is high among the government and domestic society representatives (World Bank 2001). Consequently, the Ninth National

Economic and Social Development Plan (9th Plan) for 2002-2006 emphases that preservation of biological resources is significant as a basis for supportable poverty reduction (World Bank 2001).

The Green Revolution had undesirable results onto public health which were caused by the inappropriate use of pesticides, separately from these socio-economic and ecological problems. The use of pesticides has significantly increased in the previous twenty years (IPM Thailand 2003). The pesticide utilization was at 1,3 million tons and 2,406 cases of pesticide poisoning were reported in 2003 (WHO 2004). However, the tangible statistics are considered to be much higher than stated because very few agriculturalists go to hospital when they sick and many deaths happen without the reason ever having been noted.

The symptoms of pesticide poisoning were found in 68% of the observed vegetable agriculturalists in Kanchanaburi province (IPM Thailand 2003). More than 90% of farming workers in Thailand are affected by agrochemicals. Contamination with these materials leads to exhaustion, nausea, headaches, dizziness, and itchy skin. Not only can pesticides lead to sickness, they are also accountable for low quality of work and reduced production (IPM Thailand 2003). There are many projects and activities in Thailand trying to support to resolve these environmental and socio-economic problems. There are three powerful strengths are worth stating here the King of Thailand: sustainable development projects, NGOs and Buddhism.

1.4 Appropriate technology in Thailand

The appropriate technology common definition is technology that is designed to solve social, environmental, cultural, economic and community situation problems around the world to sustain natural resources. The appropriate technology from sustainable development projects is implemented in different areas in many countries, to promote rural development (CSIR Built Environment Unit, 2008). The objectives of the sustainable development projects in Thailand focus on self-sufficiency and environmentally-friendly farming. Knowledge gained from the projects can be divided into six dimensions: land, water, forestry, agriculture, environment and alternative energy. The sustainable development projects create substantial amounts of valuable appropriate technology and individual practical experience, which is crucial in strengthening communities. An appropriate technology should be effective in practice and easy to maintain for many people. Moreover, an appropriate technology must be affordable and have a wide impact.

The appropriate technology is a proper technology to inspire people which is sustainable, health information, energy, environment, air, water, food and housing. The appropriate technology principles are communities' requirement be authorized to access and manage the community resources they require to be self-sufficient and sustainable. The trusting and valuing ability of local societies form create their own vision for their future, as well as the way to change toward it by appropriate technology. The clearness and participating decision-making consideration is essential to the goal of community justice and sustainability including economy, society, and environment. The effort toward environmental sustainability must be significance for all societies to certify peace and success for all peoples. Additionally, the appropriate technology is concerning and appreciating the differences and diversity among our collaborators and our residents.

There are more than 4,000 sustainable development projects creating appropriate technology across Thailand. The knowledge and practical experience from these projects is implemented in different areas of Thailand to promote local development. The objectives of the sustainable development projects focus on self-sufficiency and environmentally friendly agriculture. Knowledge gained from the projects can be divided into six dimensions; land, water, forestry, agriculture, environment and alternative energy. The sustainable development projects create significant amounts of valuable knowledge and individual practical experience. This knowledge can be applied to the various social landscapes of Thailand. For example, knowledge from Huai Hong Krai Royal Development Study Center has been used to increase agricultural output and reduce poverty for local communities. Knowledge from the Royal Projects has also encouraged grass roots development, which has in turn promoted sustainable and successful community development. Traditionally, knowledge from the appropriate technology of sustainable development projects has been utilized in a piecemeal way at local geographic scales. This has led to duplication in effort and the full potential of Royal Project knowledge not being met.

The need to store and share appropriate technology knowledge requires a method to structure knowledge from multiple projects, so that this knowledge can be shared in order to solve rural community problems. Furthermore, managing appropriate technology knowledge would allow local communities to learn from collaborative and expert experience to create new solutions to problems. Thus, a requirement exists to manage appropriate technology knowledge and extend this knowledge to other social landscapes across Thailand.

Presently, agricultural economics and agricultural manufacture are facing to many issues that are some important issues are as follow: concentration of agricultural production in some period cause lack or over of agricultural production and it also lead to the crisis in the value of production. Moreover, the climate change by the Global Warming Effect has important impacts on conditions affecting farm in Thailand such as increased occurrence of weather extremes (i.e. droughts, storms, floods), damage of biodiversity in breakable surroundings and tropical woodlands, damage of productive coastal areas affected by rising sea levels, increase in occurrence of animals and vector borne diseases, more unpredictable agricultural situations in tropical regions and capacities of fish and sea nourishments and dramatic changes in distribution. These situations define the carrying capacity of the environment to produce enough foodstuff for the Global population and domesticated animals. Additionally, the understanding and applying appropriate technology knowledge would also increase the agricultural production capability and effectiveness. Agriculturalists can raise their incomes leading to sustaining of landowner status, developing and preserving their agricultural livelihood where the poverty may not be reoccupied.

This research proposes a knowledge transfer and knowledge representation using knowledge engineering approach with the objective of using additional social science ontologies to provide a solution to the knowledge management problem. This study focuses on organic rice farming as an appropriate technology to develop effective social science ontologies and transfer vocational knowledge to non-science and technology educated farmers in Phrao farmer's community in Thailand as a case study.

1.5 The basic education situation in Thailand

The Ministry of Education broadcasted implementation of the basic education curriculum 2001, which obliged as the core curriculum for national education at the basic level. The basic education in Thailand is divided into six years of primary schooling followed by 3 years of lower secondary and 3 years of upper secondary schooling. Eight core subjects form the National Curriculum are Thai language, mathematics, science, social studies, religion and culture, health and physical education, arts, careers and technology, and foreign languages. The primary school curriculum is the basic education which aims at providing experience applicable to learners' daily living. The lower secondary schooling aims at providing lesson learn a general educational program of socialization for learners. Therefore, the upper secondary schooling curriculum provided vocational knowledge which intended for students hoping to further their education at university.

According to Thai education system provides 9 years: Pratom 6 of compulsory education, with 12 years: Mattayom 3 of free basic education guaranteed and set by the 1999 National Education Act. In 2003, compulsory education was extended to 9 years, with all students expected to complete with 15 years: Mattayom 6 shown in Table 1.1 (Ministry of Education, Thailand, 2008). Most of rural people in Thailand had education at elementary education level which are elementary school (Pratom 4-Pratom 6) 92.58%, lower secondary school (Mattayom 1-3) 46.82% and upper secondary school (Mattayom 4-6) 25.29% shown in Table 1.2. (Office of the Permanent Secretary, Ministry of Education, 1992). Moreover, it can be seen from Office of the Permanent Secretary, Ministry of Education, (2013) that most rural people at 91.36% in Thailand complete elementary education level more than other levels.

The evaluation of the Thai curriculum in application was based on studies and monitoring which were shown the outcomes of several problem such as lack of clarity, its application and emerging unsatisfactory outcomes, resulting in confusion and uncertainty of practitioners at school level in preparing their own curriculums. Moreover, problems regarding learners' ability to acquire essential knowledge, skill, capacities and desired characteristics were disconcerting.

The findings highlight a lack of specification of conceptualization understanding in basic education level of rural community people in Thailand being unsuccessfully transferred appropriate technological knowledge which is maintained in the sustainable development projects. The social science and technology ontology in appropriate technological knowledge should be the keystone of sustainable development projects, which knowledge workers need to understand and solve real world problems. The result from analysis of this research is that this lack of understanding of specification of conceptualization in appropriate technological knowledge should be addressed via a knowledge management solution.

Table 1.1 Number of Students in the Formal School System as a Percentage of School-age Population by Level of Education, Grade: Academic Year 2013

Level of Education/Grade	Age	Number of Students			School-age Population*	Students as a Percentage of School-age Population**	Students as a Percentage of total Students***
		Male	Female	Total			
Elementary Education	6-11	2,533,424	2,372,036	4,905,460	4,775,667	102.72	37.81
Lower Secondary Education	12-14	1,216,112	1,175,278	2,391,390	2,471,730	96.75	18.43
Upper Secondary Education	15-17	993,610	1,150,508	2,144,118	2,856,123	75.07	16.52

Table 1.1 Number of Students in the Formal School System as a Percentage of School-age Population by Level of Education, Grade: Academic Year 2013 (Continued)

Level of Education/Grade	Age	Number of Students			School-age Population*	Students as a Percentage of School-age Population**	Students as a Percentage of total Students***
		Male	Female	Total			
Undergraduate Degree and Below	18-21	771,360	1,014,007	1,785,367	3,840,838	46.48	13.76
Graduate Degree		94,202	135,555	229,757	-	-	-

Table 1.2 Number and Percentage of Students in the Formal School System by Level of Education and Grade in Bangkok Metropolis and other Provinces: Academic Year 2013

Level of Education/Grade	Bangkok Metropolis		Other Provinces		Total
	Number	%	Number	%	
Elementary Education	423,799	8.64	4,481,661	91.36	4,905,460
Lower Secondary Education	217,347	9.09	2,174,043	90.91	2,391,390
Upper Secondary Education	256,120	11.95	1,887,998	88.05	2,144,118
Undergraduate Degree and Below	936,061	42.80	1,250,761	57.20	2,186,822
Graduate Degree	139,188	60.58	90,569	39.42	229,757

1.6 Appropriate technology knowledge transfer to rural people in Thailand

The Government strategies relate to agricultural development contributing to promote agricultural improvement based on the appropriate technology from sustainable development projects as a significant for small farmers; together, increase opportunities for agricultural product development and improve quality of farming product through the use of appropriate technology, suitable and sustainable management and access to marketplaces. Knowledge of appropriate technology can be considered a valuable resource of communities and the strength of a community are a critical foundation in the provision of a sustainable economic and cultural development process (Nonaka *et.al*, 2000). Knowledge management is a concept that can therefore be applied to communities in order to facilitate sustainability in their development. The use of knowledge, local resources, skills and wisdom can be used to solve issues of poverty as well as issues of environmental and resource management. This is particularly important for the social landscape in Thailand, where there is a relatively high inequality of income distribution (CIA, 2006). To counter this inequality, the sustainability development projects were setup in 1951 (Office of The Royal Development Projects Board, 2011), yet there is currently no formal knowledge management process within the sustainable development projects' framework and as a result, these projects are not maximizing their potential in terms of managing and using knowledge. This means there is a requirement to effectively structure, store, share and reuse knowledge generated by the sustainable development projects. This requirement represents potential for research, which aims to develop a solution to this problem.

In the knowledge management process, knowledge acquisition is the initial step, which emphasizes individual human expert knowledge capability in organizations (Nonaka, 1994, Aujirapongpan, 2010). Knowledge acquisition is a method of learning, which involves complex cognitive processes, perception, learning and reasoning. The acquisition of knowledge can be derived from human experts, research paper, books, and work practices, documentation of various internal and external knowledge resources (i.e. environmental data, clients' data, competitors' data and other resources, including external benchmarking (Birkinshaw 2002, Marquarde, 1996) Organizations require knowledge acquisition that is useful to their organizational vision and strategy (Zack, 1999). As mentioned previously, sustainable development projects and research papers acquire comprehensive appropriate technology knowledge, but do not currently share and reuse knowledge effectively, meaning the tacit knowledge from researchers, practitioners and expert knowledge workers could be harnessed to reduce appropriate technology costs and improve project quality. The appropriate technology also focuses on economic knowledge rather than social scientific knowledge and knowledge from academic research is more complicate and more sophisticate to share to rural people to understand and apply this knowledge for their community. Quantitative and qualitative measurements of knowledge both affect the knowledge acquisition capability (Probst, 2000). Information technology and organizational structure, including leadership and existing organizational culture, are considered vital organizational resources to support and make knowledge acquisition and accessibility efficient (Freeze 2006, Gold 2001, Hendriks 2001, Vouros 2003). In addition, best practice or benchmarking is frequently utilized to make knowledge acquisition effective (Peachey 2006). The knowledge acquisition process aims to elicit knowledge, analyze concepts and formalize domain knowledge. Once knowledge has been elicited, there is a need to appropriately structure this knowledge. In the appropriate technology domain knowledge, this need stems from the number of knowledge workers and researchers, research papers, documents, repositories, portals and appropriate technology created by sustainable development projects across Thailand. The requirement to structure knowledge is driven by the need for storage, and to reach a common understanding, which will help to avoid the loss of tacit appropriate technology knowledge from sustainable development projects. Additional social science ontologies brought together within a knowledge management perspective offer a potential solution to the appropriate technology knowledge transfer problem are described below.

The first year study of this research investigated a sustainable development project case study focusing on the Chaipattana Aerator. The Chaipattana Aerator is a water oxygenation device, which requires scientific and technology knowledge to build and operate. The Chaipattana Aerator is also a patented invention known worldwide for its effectiveness in increasing oxygenation to reduce water pollution and is particularly useful in rural areas. When individuals and communities need to learn about or build an aerator for their community, they could learn from existing Chaipattana Aerator knowledge if it was effectively stored and structured. First year preliminary research constructed knowledge ontologies of the Chaipattana Aerator by extracting key concepts from the geosocial philosophy of His Majesty Bhumibol Adulyadej, the King of Thailand (Ruanglertboon, 2003), which was based on a Buddhist Philosophy. This philosophy acted as an ontological framework, which was related to the key philosophies of the Royal Project. The knowledge collected in stage one was classified according to the King of Thailand’s working concepts of principle, essence, and practice. The principle-working concept is for theoretical and general knowledge generated by the Royal Initiative Projects. The essence working concept’s main idea is to apply knowledge to solve problems for Thai citizens. The practice-working concept is to understand problems and access requirements of people and then provide a solution, so that people can create knowledge in order to develop their community. In parallel to this, a formal ontological framework was developed using semantic annotation with experts’ jargons. Initial findings of the first year project showed explicit knowledge exist in the sustainable development project, but mainly in the form of economic information and documentation. Expert scientific and technology knowledge was lacking. Universities, government officers, and a new generation of experts conducted many projects. The sustainable development project stakeholders and researchers tend to utilize and transfer this appropriate technology knowledge without suitable knowledge representation for rural community people who are non-social science educated. In the first year project, a lack of knowledge from within the sustainable development project was identified the findings of the first year research also highlighted a lack of scientific knowledge being stored or maintained in the sustainable development projects. Scientific and technology knowledge should be the keystone of appropriate technology knowledge from sustainable development projects, which knowledge workers can understand and used to solve real world issue problems. Most sustainable development project documents defined only capital, budgets and policy, but did not describe scientific processes or talk about knowledge delivery (episodic knowledge) and most research papers defined academic concepts that are very difficult for knowledge workers to understand and apply for their community. The result from analysis of this first year project is that the lack of scientific knowledge should be addressed via a knowledge management solution. In terms of knowledge synthesis, first year research results showed people prefer to learn and remember from episodic knowledge scenario such as comic books and training courses.

There are many researches about appropriate technology, which were needed to transfer knowledge from the research results to local community as well. The use of knowledge, finding of researches, local resources, skills and wisdom can be used to solve issues of poverty as well as issues of environmental and resource management. This is particularly important for the social landscape in Thailand where there is a relatively high inequality of income distribution.

According to results from the first year project, much of the sustainable projects' explicit knowledge is economically based information, while social scientific knowledge remains tacit. Capturing, structuring, sharing and utilizing tacit social scientific knowledge within the sustainable projects' represent an important research challenge. The finding of appropriate technology knowledge transfer is rural farmers in Thailand who have not enough of basic education and science technology knowledge to understand and apply appropriate technological knowledge or expert's jargons for solving their rural community problems successfully.

Knowledge of the appropriate technologies for sustainable development projects has encouraged grass roots development, which has in turn promoted sustainable and successful community development, which a requirement is to share and reuse this knowledge effectively. This research aims to propose a tutorial ontology effectiveness modeling on organic rice farming as an appropriate technology based on sustainable development projects for non-science and technology educated farmers using knowledge engineering approach, using Phrao District in Chiang Mai Province, Thailand as a case study. The effective tutorial ontology model focuses on social science and technology ontologies based on Thai curriculum of lower secondary school which provides biology, chemistry, math and physics concepts in order to effectively represent knowledge of the organic rice farming. The additional science ontology knowledge developed in this research provides such a support to vocational learning and used by rural community in the case study to effectively navigate and utilize the appropriate technological knowledge of the sustainable development project knowledge to enhance their communities. The additional social science ontology knowledge developed in this research provides such a support to vocational learning and used by rural community to effectively utilize the appropriate technological knowledge to enhance their communities. The benefits of social science ontologies in supporting knowledge for non-science and technology educated farmers as learners were assessed using the measurement in learning process by innovative semantic annotation technique on Bloom's Taxonomy vocabulary. The non-science and technology educated farmers learned organic rice farming domain knowledge from experts to improve and develop their communities which was measured by semantic annotation on Bloom's Taxonomy using a CommonKADS which provides tools for structuring knowledge and identify cognitive level of learners in learning process. The effectiveness of tutorial social science ontology in learning process was measured by counting and validating the average throughput of organic rice farming domain knowledge in learning process in terms of practicing domain knowledge, appropriate domain knowledge with their community and acquiring knowledge by themselves in both control and experimental groups. This study concludes by emphasizing the benefits of effective tutorial ontology modeling on organic rice farming for supporting knowledge transfer technique for non-science and technology educated farmers using knowledge engineering in the community of the case study to enhance their vocational life-long learning. Ultimately, the tutorial ontology modeling in appropriate technology provides a knowledge transfer for non-science and technology educated farmers effectively.

1.7 Research problem justification

The appropriate technology knowledge and academic researches transfer to rural farmers in Thailand who have not enough of basic education and science technology knowledge to understand and apply these knowledge or expert's jargons for solving their rural community problems unsuccessfully.

1.8 Research Aim

1.8.1 This research provides tutorial social scientific ontology knowledge of appropriate technology from sustainable development projects and researches for local people in Phrao community.

1.8.2 The appropriate technology knowledge transfer is increasing in order to improve local people capital for solving problems in their communities. Consequently, the appropriate technology knowledge is disseminated to people in local area via additional tutorial ontologies as knowledge representation.

1.8.3 This study aims to propose a knowledge transfer framework for local community by implementing knowledge and appropriated technology to improve their sustainable community. To meet this aim, the following research objectives will be arise.

1.9 Research objectives

1.9.1 To prove that people who graduated lower than under secondary school (Mattayom 3) are lack of social science knowledge as basic education.

1.9.2 To suggest social scientific basic education based on biology, chemistry, physics and mathematics that useful for people who are non-science and technology educated working class people.

1.9.3 To prove that semantic annotation on Bloom's Taxonomy measuring learning process and cognitive level of learners in appropriate technology knowledge from sustainable development projects.

1.9.4 To prove that science ontology as knowledge representation for transferring knowledge effectiveness.

1.10 Research hypothesis

1.10.1 The tutorial social science ontology as knowledge representation can transfer appropriate technology and academic research knowledge effectiveness for non-educated science learners and improve learning process behavior of non-educated science learners.

1.10.2 The measurement approach by semantic annotation on Bloom's Taxonomy assesses learning process and cognitive level of learners in appropriate technology knowledge from sustainable development projects.

1.11. List of Publication

1.11.1 Jirawit Yanchinda, Nopasit Chakpitak and Pitipong Yodmongkon, "Creating Ontologies for Knowledge Management: Chiapattana Aerator Project, SKIMA 2011 Conference, University Benevento, Italy. (Conference Proceeding)

1.11.2 Jirawit Yanchinda, Pitipong Yodmongkon and Nopasit Chakpitak, "Using Ontologies for Knowledge Management: Chaipattana Aerator Project, ICICKM 2011 Conference, Bangkok University, Thailand. (Conference Proceeding)

1.11.3 Jirawit Yanchinda, Pitipong Yodmongkon and Nopasit Chakpitak, "A New Knowledge Management Framework for an Environmentally Sustainable University in Thailand", SKIMA 2012 Conference, Chengdu, China. (Conference Proceeding)

1.11.4 Jirawit Yanchinda, Napaporn Reeverakul and Pitipong Yodmongkol "Sustainable Framework of Agricultural Knowledge Transfer From Researchers to Local Community in Thailand", SKIMA 2013 Conference, Chiang Mai. (Conference Proceeding).

1.11.5 Jirawit Yanchinda, Nopasit Chakpitak and Pitipong Yodmongkol, "Effective Tutorial Ontology Modeling on Organic Rice Farming for Non-Science & Technology Educated Farmers Using Knowledge Engineering", *International Education Studies*, Vol. 8, No. 9, 2015 pp 46-57.

1.11.6 Jirawit Yanchinda, Pitipong Yodmongkol and Nopasit Chakpitak, "Measurement of Learning Process by Semantic Annotation Technique on Bloom’s Taxonomy Vocabulary”, *International Education Studies*, In Press, 2015.