Highland Management in Rotation and Mono Cropping Systems of Li Sub-watershed, Lamphun Province

Pongsatorn Kumjainuk

Faculty of Humanities and Social Sciences, Lampang Rajabhat University, Thailand
E-mail: pongsatorn@live.lpru.ac.th

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Abstract

The objectives of this research are: 1) To compare the factors of land tenure, ecological aspects, economic conditions, perception of information and wisdom affecting the selection in highland rotation cropping and mono cropping. 2) To analyze and identify differences in land management between highland rotation cropping and mono cropping. And 3) to analyze and assess the link between the intensive highland rotation cropping and mono cropping with soil management and degradation. There were quantitative and qualitative data collections from farmer groups of both systems by using the tools as questionnaires and in-depth interviews with participant observation including exploring the research area plot. The data were analyzed using descriptive statistical method in the form of frequency distribution, percentage and comparison table. The results showed the land tenure of the two highland cropping systems was not different. There were no documents and rights over the lands. Rotation cropping system focused on intensive commercial agricultural production, whereas mono cropping system focused on subsistence. Both systems used traditional wisdom. The characteristics of rotation cropping were separated rotation cropping with legumes and no legumes, so crops could be grown throughout the year and continuously. Therefore, the soil management was intensive and the soil was not time for resting. The characteristics of mono cropping system involved growing only one type of crop every other year and year after year. There was a one-year soil resting and the mono crops were replanted annually, so there was not the soil resting. There are differences in the use of chemical fertilizers and concentrated chemicals, as well as soil fertility. It could be concluded that both of cropping systems were not different and had moderate fertility The soil erosion in rotation cropping system was very low to moderate level, thus soil condition was sustainable. The soil erosion in mono cropping system was low to very severe level, thus soil condition was not sustainable.The policy and action recommendations, the government should support in terms of alternative agricultural policies and budgets for developing highland areas seriously and comprehensively in accordance with the sufficiency economy.

Keywords: Highland management, Rotation cropping, Mono cropping

Introduction

In Li Sub-watershed area, Ban Puang Sub-district, Thung Hua Chang District, Lamphun province, the most of population consists in Thai lowland and Thai hill tribe as Karen *(Pga K'nyau*) who were mainly engaged in agriculture and the agricultural areas were permanent multi-system cropping. The intensive rotation cropping and mono cropping for both commercial and subsistence systems at highland, upland and lowland area, the small river flowing through the year and the main crops cultivated were paddy rice, upland rice, corn and shallot. The study areas were Ban Mae Bon Nuea, M. 1 and Ban Mae Bon Tai, M. 10 which the bost of villagers were White Karen or *Pga K'nyau*. The problem situation in Li Sub-watershed area were the population increases but the agricultural area had the same area so resulting in intensive use of the production area and the highland areas along the former Li Sub-watershed had been declared national forest reserves by the Royal Forest Department for control and conserve forest areas. It was considering as a strict and lawful management of existing forests and it had brought problems over the farming areas of the villagers who lived in forest areas. They have cleared the forest areas for shifting cultivation in the original community areas and it was illegal to farm in their native locations. It eventually become conflicts between the government and the villagers that causes problems in highland agriculture due to the plantation of short-term crops. (Boonchai, 2016For instance, all the soil covers are cleared during the soil preparation. The conditions of slopes cause soil erosion. Improper cultivation and burning weed in the plots cause minerals and soil organisms, such as earthworms and other beneficial insects, are destroyed and ecosystems are damaged. Especially in terms of soil resources, when agricultural activities are carried out, it causes soil deterioration and increasing of consumer demands. Therefore, they accelerate farmers to increase agricultural productivity by using more inputs, sources of capital, increasing their debt burden. What has been overlooked is the cultural control and soil management. From such phenomena, highland farmers have continued to cultivate traditional crops, although they have known that they may lose because of the uncertain marketing, productivity and price. Different planting systems of farmers affect changes in soil resources in terms of soil fertility and soil erosion. Is there soil management or not? In terms of production efficiency and sustainability, can it be implemented or not? (Kampolkon, 2004).

Therefore, the issues had been a research study on the topic of highland management in rotation and mono cropping systems of Li Sub-watershed, Ban Puang Sub-district, Thung Hua Chang District, Lamphun Province and the research questions were the two highland cropping systems which are highland rotation cropping system, which grow leguminous plants alternatively with crops and do not grow leguminous plants alternatively with crops and it has been practiced for two to three years, and mono cropping system, which grows only one type of crop every other year and grows only one type of crop year after year in the same plot. What conditions of both cropping systems that determine soil management, differences of crops, external factors of production that affect the stability of agricultural production, whether it is sustainable or not?

Objectives

1. To compare the factors of land tenure, ecological aspects, economic conditions, perception of information and wisdom affecting the selection in highland rotation cropping and mono cropping.

2. To analyze and identify differences in land management between highland rotation cropping and mono cropping.

3. To analyze and assess the link between the intensive highland rotation cropping and mono cropping with soil management and degradation.

Benefits

1. Government agencies understand that the farmers who have managed the land in the highland cropping systems and the farmers who have lived in the highland are able to participate in soil management in highland cropping systems.

2. To understand the conditions that affect farmers in terms of soil management in the highland cropping systems, land tenure, production systems, income, production costs, and changes in soil quality and farm ecology.

3. Farmers in the highland are able to adapt the soil management methods and to solve problems of soil quality and ecosystem of farmers in highland cropping systems.

Conceptual frameworks

A conceptual framework is on farmer's land management in highland rotation cropping and mono cropping systems in Li Sub-watershed. Each cropping system has different conditions. The highland rotation cropping system has conditions relating to land ownership due to the limitation of lands. The state announced a law that controls national forest reserves and national park areas that overlapped with the arable lands. Thus, farmers are unable to reclaim new planting areas by having conditions in terms of the ecology of the area, slopes, height above sea level that is different according to the topography, transportation and distance. (Boonchee et.al., 1997)

It also consists of the economic conditions of the households in the highland rotation cropping system throughout the year which requires external inputs such as chemical fertilizers, chemicals, and capitals. Planting of this cropping system depends on conditions of knowledge acquisition, information and news from various development projects that educate and promote intensive commercial crop rotation until it turns into permanent agricultural plots and cannot be planted as before. As a result, farmers have to adapt to practice mono cropping system. In the past, the soil was left for 7-12 years to allow the lands to turn into forests, and then to clear again. The cultivation period was shortened with the condition of land tenure. The two cropping systems have different cultural control and soil management. Highland rotation cropping system is practiced throughout the year in the same area year after year and grows leguminous plants alternatively with crops and do not grow leguminous plants alternatively with crops and also increases productivity by using external factors to support, such as plant varieties, chemical fertilizers, chemicals, and capital utilizations, both cash and contract agriculture. The number of labors depends on the size of the cultural control and soil management, weed removal, soil digging, plot preparation, raising trenches and across the slope of the area. While

farmers, who practice mono cropping system, have also adapted to grow crops, some farmers grow the same crop in the same area year after year. Some grow the same crop every other year. However, mono cropping system, cultural control and soil management by mulching methods and soil improvement has applied natural methods. The current rotation cropping system is planted in the same area and use intensive inputs and management causing soil erosion. The quality of the soil is deteriorated and yields have declined sharply. In the study and evaluation of soil fertility and soil loss together with comparative plots in order to distinguish the different conditions. Crop rotation is practiced in the same area year after year. When it is evaluated for soil erosion, soil loss, and soil fertility by randomly collecting soil samples for analysis and conducting research according to the conceptual framework, it reveals the dynamics of farmers' land management in the two highland cropping systems. Conditions and factors that determine the success or failure of farmers in soil management in the two highland cropping systems are being studied in order to find guidelines for developments and solving problems to meet the needs of farmers. Hence, natural resources, soil, water, and forests are more sustainable and are able to reduce conflicts in various dimensions (Shiner et. al., 1982) (see Fig. 1, the conceptual framework of the research).

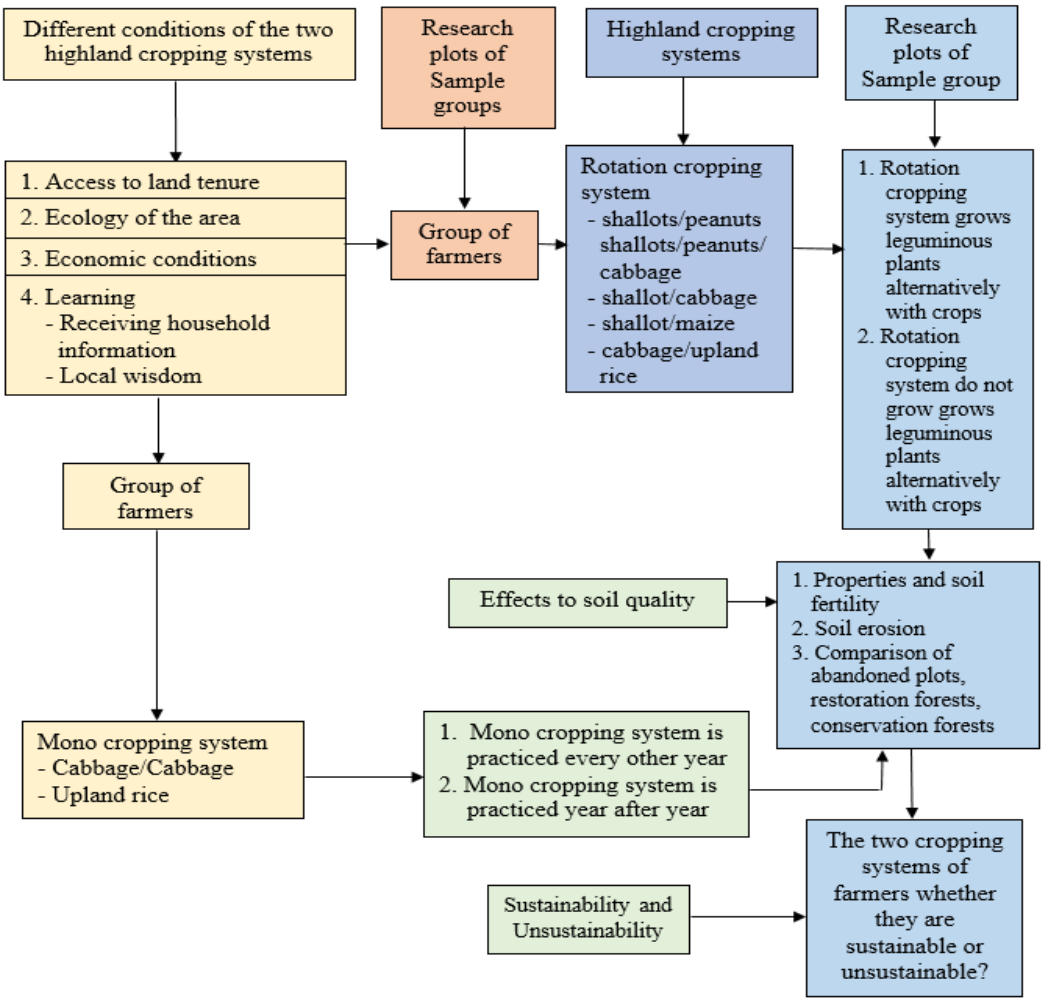

Figure 1 Conceptual Frameworks

Methodology

1. Locale of the study

This research study was conducted in Li Sub-watershed, Mu 1, Ban Mae Bon Nuea and Mu 10, Ban Mae Bon Tai, Ban Puang Sub-district, Thung Hua Chang District, Lamphun Province. The villagers were White Karen or *Pga K'nyau*. The research plots were selected based on the size of the area, slope, type of crops planted in each plot per year, soil management as well as the intensive use of inputs which were not significantly different in the groups that produced commercial crops.

2. Research population and sampling

Groups of farmers, who still stick to traditional farming practices, were selected, including the selection of information on the cultivation patterns of the farmers in order to determine the sample plots of the two systems: rotation cropping and mono cropping systems.

3. Instrumentation and data collection

The researcher selected a research methodology and data collection, both quantitative and qualitative data from groups of farmers of both cropping systems.

Tools, which were used in research studies.

1) The questionnaires and

2) In-depth interviews of sample population, community leaders, local experts and relevant government officials by emphasizing participant observation, including exploring the research plots.

4. Data analysis

Data analysis and interpretation, which were used in presentation, obtained from the questionnaires and surveying of plots and in-depth interviews. Data from sample groups of farmers, both primary and secondary data, and discussion of the results of the study presented quantitative and qualitative data by using statistical processing and displaying the results with a frequency distribution table, percentage, comparison table, pictures, and maps. which applied Geographic Information System (GIS) for analysis the data more clarity and accuracy. (Huizing & Bronsveld, 1992)

Results

Changes in land use from the original forest areas were used as the residential area and agricultural lands. The result of the increasing number of population caused conflict over land rights and forest utilization. It caused intensive commercial agriculture; as a result, it created changes and problems in land use. At the same time, changes and problems of land use created conflicts over land rights, forest utilization and intensive agriculture and different cropping management. The results of the study can be summarized as follows:

1. Conditions of land tenure, ecology condition, economic condition, perception of information and local wisdom affecting the choice in two cropping systems.

For the results of the study on the conditions of farmers affecting the selection of rotation cropping system and mono cropping system, it can be summarized as follows:

Table 1 Farmer's conditions affecting the selection of the rotation cropping system and the mono cropping system

Farmers' conditions	Rotation cropping system	Mono cropping system
1. Land tenure	Not different in the both of farming and residential areas that no title documents or deeds. Those areas were located in a national forest, therefore, villagers were unable to reclaim or expand the new arable lands. However, they still had the rights to use the lands which have been farmed before.	Not different in the both of farming and residential areas that no title documents or deeds. Those areas were located in a national forest, therefore, villagers were unable to reclaim or expand the new arable lands. However, they still had the rights to use the lands which have been farmed before.
2. Ecology	1. Not different in terms of the location of the arable area, the elevation above sea level, the physical characteristics, and size of the research plot. 2. The difference in percentage of slope that less steep, the size of the average arable area and the size of the arable area as larger than .	1. Not different in terms of the location of the arable area, the elevation above sea level, the physical characteristics, and size of the research plot. 2. The difference in percentage of slope that steeper than, the size farm area that average large plots and the amount of arable area were less than.
3. Economic	1. Not different in terms of crop cultivation factors such as temperature, climate, rainfall, relative humidity, marketing and agricultural tools. 2. Difference in production cost and average annual income. There was stability and less risk in terms of yield and price, and labor intensive.	1. Not different in terms of crop cultivation factors such as temperature, climate, rainfall, relative humidity, marketing and agricultural tools. 2. Difference in production cost and income on average per year more stable, higher productivity and price risks and not much labor.

Farmers' conditions	Rotation cropping system	Mono cropping system
4. Perception of information and local wisdom	1. There was no difference in the use of plant varieties, area selection, temperature, wind and sun direction, moisture, watershed forest, observation of soil fertility, drainage management. The Using of Karen Tribal Cultivation Calendar with the general planting calendar. 2. Different in the amount of arable area, each person was more or less not equal. The ideas in terms of preserving culture, traditions, and the tribal ways of life for farmers who rotate crops will focus on commercial production.	1. There was no difference in the use of plant varieties, area selection, temperature, wind and sun direction, moisture, watershed forest, observation of soil fertility, drainage manage- ment. The Using of Karen Tribal Cultivation Calendar with the general planting calendar. 2. Different in the amount of arable area, each person was more or less not equal. The ideas in terms of preserving culture and traditions. Farmers who grow crops in mono mono cropping had many plots and it also adheres to traditional methods of growing crops.

From table 1, farmer's conditions affecting the selection of the rotation cropping system and the mono cropping system as followed: 1) In the aspect of rights to access land resources: not different in the both of farming and residential areas that no title documents or deeds. Those areas were located in a national forest, therefore, villagers were unable to reclaim or expand the new arable lands. However, they still had the rights to use the lands which have been farmed before. In case the lands were far away from the village, forest officials set up as a conservation forest area. It could be considered that they were being pressured by government policies. Thus, there was no stability in land tenure. 2) Ecological classification: Plots of farmers in the two cropping systems were not different. The plots were located in the north of the village with the height of 1,197 meters and 1,165 meters above mean sea level. The sizes of research plots were small and the plots were about 3 rais. The distance from the village to the agricultural plots were 1.2 kilometers and 1.9 kilometers on average. The difference was the percentage of slope. The rotation cropping system had an average slope area of 27.6 percent. The mono cropping system had an average slope area of 37.8% which was steeper than large arable lands. The average size of plots of rotation cropping system were about 6-9 rais. The mono cropping system was about 6 rais. The number of plots of rotation cropping system was 81 rais of crops and the mono cropping system was 24 rais. It showed that mono cropping system in area had been reduced. 3) In the aspect of economy: the rotation cropping system had more production costs and income in average per year. This system had stability and less risk of productivity and price than mono cropping system because the rotation cropping system had varieties of

crops. The factors which related to crop cultivation such as temperature, climate, rainfall, relative humidity, and marketing were not different. The use of labor in the rotation cropping system was more labor intensive than mono cropping system. The uses of agricultural tools were not different. And 4. In the aspect of the perception information and local wisdom: There was no difference in the use of plant varieties, site selection, temperature, wind and sun direction, humidity, watershed forests, observations of soil fertility, drainage management, the use of *Pga K'nyau* cultivation calendar in conjunction with the academic general cultivation calendar. The differences were the number of arable area for each individual that were not the same. In the aspect of conserving culture, traditions and tribal livelihood of farmers who practiced rotation cropping system focused on commercial production. As for farmers who practiced mono cropping system had number of plots of land and still stick to the traditional *Pga K'nyau* method of planting which was the production of subsistence. However, they did not deny the commercial production system.

2. Differences in soil ecosystems, soil characteristics and soil properties of the two cropping systems.

2.1 Ecosystems and soil characteristics had the same characteristics. Organism was still diverse. The soil characteristics had ability to drainage water. The soil texture was sandy loam which was in the soil groups' No. 62 and was at high risk of soil erosion and soil loss. The differences were the relationship between crops and crops in rotation cropping system. Crops were related and depended on each other for the appropriate time and season. There was a use of chemical fertilizers and soil improvement because legumes were planted in rotation as soil nourishing crops. However, the mono cropping system had no relationship between crops to crops because it was a monoculture which was the practice of growing one crop species in a field at a time a single plant. This system relied on soil improvement by allowing a rest period and applying manure. In monoculture crops, crops were grown every other year, but only in some cases.

2.2 Chemical and biological properties of soil: Plots of both cropping systems and the comparative plots could be concluded that plots of both cropping systems and abandoned plots. The soil condition was very acidic and moderately fertile. Abandoned plots had high soil fertility. The noticeable difference was comparative plots, restoration forests, and conservation forests which soil was moderately acidic and had very high in organic matter, nitrogen, potassium, calcium and magnesium. Those nutrients were higher than both cropping systems and more than abandoned plots.

3. Differences in soil erosion and soil loss.

3.1 Soil loss: Rotation cropping system depended on planting method and percent of slope. Plots with less than 20 percent of slope had soil loss ranged from 1.2-2 tons/rai/year and the severity level were very low. Plots with 20-30 percent of slope had soil loss ranged between 3-4 tons/rai/year and the severity level were low. Plots with more than 35 percent of slope had soil loss between 6-9 tons/rai/year and the severity level were moderate.

3.2 Soil loss: Mono cropping system had plots with less than 20 percent of slope and soil loss was 3 tons/rai/year. The severity level were very low. Plots with more than 35 percent of slope had soil loss of 30 tons/rai/year and the severity level were very severe.

3.3 Soil loss: Abandoned plots with less than 20-30 percent of slope had soil loss of 0.9 tons/rai/year and the severity level were very low. The restoration forest plots with more than 35 percent of slope had soil loss about 0.4 tons/rai/year and the severity levels were very low. The conservation forest plots with more than 35 percent of slope had soil loss of 0.18 tons/rai/year and severity level was very low.

In summary, soil loss was compared depending on the cropping method and the soil moisture percentage for slope of the area, it was found that abandoned farm plots had the least severe soil loss. The followed by the plots of the crop rotation system and the plots of the mono cropping system had the most severe soil loss.

Discussions

There is no difference in terms of land tenure and ecosystems, but there is a difference in economic status. Farmers who grow crops in rotation cropping system use higher capital and inputs and earn more net profit per year than mono cropping system. There is no difference in the perception of information. Farmers who grow crops in rotation cropping system receive knowledge from government agencies and non-governmental organizations from abroad and nearby villages. They obtain local wisdom by inheriting various methods from ancestors according to the livelihood of the Paganyaw people. In terms of sustainability, rotating cropping system is more sustainable in terms of soil resources and economic conditions, income and risk of product price is less than mono cropping system.

Farmers, who practice mono cropping system in the research area, have changed their crops from local crops to field crops in their original areas without relocation because there are limitations and they cannot expand new farming areas. They develop the agriculture into mono cropping system, both growing only one type of crop every other year (letting the soil rest) and growing only one type of crop year after year (Without soil rest). In this system, farmers still stick to the traditional subsistence livelihood and commercial production. As a result, it leads to fewer farmers who grow crops in this system. Cultivation of crops in the traditional livelihood of the Paganyaw tribe is embedded with beliefs, culture, nature and environment. How long and how stable can ethnic origins stand against capitalism and consumerism? And how both stakeholders and tribes should find ways to preserve traditional livelihood? (Hirsch, 1990). Those questions should be continued to study and research in order to find answers. As for the issue of comparing the effects of both cropping systems on yields and soil ecology, the research area is in Mae Li sub-watershed. The study finds out that farmers who grow crops in rotation cropping system have a crop calendar all year round. There is a high use of inputs. The crops can be harvested all year round. Average annual yields include all types of crops can be calculated for total average annual income of 70,150 baht. A production cost is 50,440 baht and net profit is 19,710 baht per year. Farmers, who practice mono cropping system, have a crop calendar from May to December. The use of inputs is less than the average annual yields. The average annual income is 22,500 baht. The cost of production is 19,600 baht and net profit is 2,900 baht. It can be seen that the net profit from the rotation cropping system has better and more sustainable incomes than mono cropping systems. For soil ecology in both cropping

systems, the soils are acidic and soil fertility is moderate. Comparative plots compare to the abandoned plots, restoration forests, and conservation forests, the soil conditions are highly and moderately acidic. The soil fertility is very high. It is noted that farmers' plots in research studies use chemical fertilizers which might remain in the soil as well. It is consistent with the academic data of Wongmaneerot (2004) described that chemical property of soil was essential for the absorption of nutrients and the utilization of nutrients. Soil had a high amount of nutrients. If the chemical property of soil was not suitable, it would reduce the usefulness of plant nutrients. What caused a yield to decrease or increase depended on certain chemical property of soil was equally important as the soil's pH. While Suksawat (2000) explained more about soil reaction or soil pH level. It was a chemical property that was very important to soil fertility. The ability of the soil in its natural state to produce a certain yield under proper management, maintenance and environmental conditions depended on soil fertility and many other factors, such as environmental factors, humidity, temperature, sunlight, soil looseness, crop production systems, such as soil preparation and watering, and weed control in order to maximize soil efficiency. It is in accordance with Hengprayoon (2004) who presented that agriculture had a production process that must sustain or maintain resources to prevent deterioration so that they could be used to produce food to support the increase of the population in the future. Farmers must have economic rewards which was incentive. This allowed farmers to continue to pursue this occupation. The production process must not destroy the environment and be accepted by society. Corresponds to Pasabud et. al. (2022) The problems in traditional farming were soil loss, nutrient loss and soil erosion that effected decreasing agricultural production. Therefore, the importance of study success factors for the integrated agriculture farming is to transfer the knowledge and promote to the interested people.

For soil erosion in both cropping systems in the research area can divide the slope of the area into 3 levels as following: less than 20 percent of slope, 20-35 percent of slope, more than 35 percent of slope. It can be concluded that the rotation cropping system has a soil loss that can be classified at a very low level and low to moderate level. It is a cropping system that has sustainability in soil conservation. Farmers who practice mono cropping system have soil loss at mild to very severe level. It is a system that has high risk to soil loss. Soil is considered to be an important production cost in growing crops. This system is considered unsustainable. The results of the above studies are consistent with the research of Boonchee (1997) who presented that the problem of soil erosion was a major problem in upland and highlands. It caused deteriorations, both chemically and physically. In the North of Thailand had moderate to severe level of soil erosion. There were approximately 9.3 million rais or 87.7 percent of the total agricultural areas of the North. For soil erosion in both cropping systems in the research area can divide the slope of the area into 3 levels as following: less than 20 percent of slope, 20-35 percent of slope, more than 35 percent of slope. It can be concluded that the rotation cropping system has a soil loss that can be classified at a very low level and low to moderate level. It is a cropping system that has sustainability in soil conservation. Farmers who practice mono cropping system have soil loss at mild to very severe level. It is a system that has high risk to soil loss. Soil is considered to be an important production cost in growing crops. This system is considered unsustainable.

Conclusion and suggestions

The results of the research can be concluded that different conditions in terms of land tenure, ecological aspects, economic conditions, information perception and wisdom that affect the selection of two. It showed that the right of land tenure of the two cropping systems was not different. There was no document and rights over the lands because it was located in the national forest area and they inherited the lands which had been passed down from their ancestors. However, both cropping systems also had the same and different conditions. In the aspect of ecology, the agricultural plots were located in the north of the village. In the aspect of physical geography, the location of rotation cropping system was grouped together and was close to each other. It could be seen that the rotation cropping system earned more and had less price risk than mono cropping system. Conditions or factors that involved in both of cropping systems which were important were temperature, climate, rainfall, relative humidity that had no difference. In the aspect of marketing, rotation cropping system focused on intensive commercial agricultural production which used high inputs of production and had a high risk of debts.

Mono cropping system was a production that focused on subsistence and was also a commercial production, but not much. It used fewer inputs and had a price risk. The two cropping systems were not different in terms of the wisdom. There was a use of traditional wisdom in the selection of plant varieties, areas, temperature suitability, wind direction, sunlight, humidity, watershed forests, soil fertility, and water management. The traditional cultivation calendar was used together with new agricultural cultivation calendar. The use of labor in rotation cropping system was more labor intensive than the mono cropping system.

There were differences in the land management of farmers in both of highland cropping system. It was found out that the soil management in the rotation cropping system, farmers needed to have good financial status or have a steady source of working capital, such as from the BAAC, Village Fund, relatives and merchants, etc. The rotation cropping system was located in the north of the village. Farmers' plots were close to each other. They gathered and set up as a group. The slope was 27.6 percent on average with the height of 1197 meters above mean sea level. The physical feature of landscape was a steep area. The soil characteristic was in the soil groups' No. 62 with some shallow surface and deep surfaces in some areas. Water resources were from natural creeks or rainwater. Forest resources were classified as mixed deciduous forest and evergreen forest. The numbers of research plot were 81 rais. The distance from the village to the agricultural plots was 1.69 kilometers on average. The rotation cropping system had been practiced in the same areas and in the same year. It could be divided into the two types of rotation cropping system. The first type grew leguminous plants alternatively with crops and the second type did not grow leguminous plants. For the cultivation calendar, farmers who grew crops in this system, crops could be grown throughout the year and continuously. The soil had been managed since March until April by weeding, burning, and using chemicals to control weeds. Farmers also made seed beddings to prepare for planting shallots, which were the first crops to be planted, followed by peanuts. Before planting peanuts, they pretreated soil

by using slaked lime. Such soil preparation method was done the same to prepare for planting other field crops. There were a variety of production factors and it had a high input of production, including weeding. Soil management was intensive. The soil did not have a rest period due to crop rotation. Soil management of farmers, who practiced mono cropping system, had been evolved from shifting cultivation which grew only one type of crop since the tribal ancestors. Farmers who grew crops by using this system did not have financial support and access to capital. It was impossible to grow many types of crops or grow the crops in large areas. The plots were located in the north of the village. The plots were scattered and far apart. The slope was 37.8 percent on average with the height of 1,165 meters above mean sea level.

The physical characteristics were the same as rotation cropping system. The numbers of research plots were 24 rais. The distance from the village to the agricultural plots was 1.84 kilometers on average. Characteristics of mono cropping system had been practiced in the same areas and every other year. It could be divided into the two types of monoculture farming. The first type was mono cropping system which involved growing only one type of crop every other year. There was a one-year break and it was considered as a non-intensive planting. The second type was mono cropping system which involved growing only one type of crop year after year. It was an intensive planting. For the cultivation calendar, farmers who grew crops in this system, the type of crop was the same every year. The soil did not have a rest period. The soil had been managed since March until April, especially the plots where crop was planted on every other year. The preparation of weeding was done by labors more than any other methods. For the upland rice planting plots, there were procedures for preparation more than other types of rice cultivation. In the plot preparation of mono cropping system, only one type of crop was replanted every year. The soil did not have a rest period. However, there were differences in the use of chemical fertilizers and concentration of chemicals.

Therefore, soil fertility was defined as moderate fertility. Properties of the soil for planting in both of the systems were not different. The rate of soil erosion in the rotation cropping system was defined as very low to moderate low level. It can be considered that the soil condition is sustainable. As for mono cropping system, the rate of soil loss was defined as low to very severe level, depending on the slope of the area. Unsustainable soil was at high risk when it was compared with abandoned plots.

Suggestions

Policy and action recommendations could be done by asking the government sector to support the budget, follow up, evaluate, and to give recommendations. The development of highland areas, which were watershed areas, could be done concretely. Budget allocation should be done to manage highland irrigation as a full-service operation. Moreover, there should be a support of alternative agricultural policy, including the policy and the budget seriously in accordance with the Sufficiency Economy Guidelines and the New Theory.

New knowledge and the effects on society and communities

If this research are approved and are corrected already, they give many advantages to agricultural parts of Thai government for improve highland management.

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