Chapter 4

Results and Discussion

4.1 Rainfall distribution in Happugasyaya micro catchments

According to the agro ecological map of NRMC of Department of Agriculture, Happugasyaya belongs to IM3 (>900 mm) agro-ecological region. Figure shows the bimodal pattern of rainfall distribution typically found in the mid country intermediate zone and for the country. During the maha season (October to January) the area receives enough rainfall for farming. Farmers start land preparation after weeding and burning for short-term crops with onset of the October rain in maha. For land preparation they spend 15-45 days according to the extent of the land and labor availability. This period is the period where 50% of the soil loss is taken place in the catchments. During the Yala season (March to May) the area receive 150 mm in April and around 50 in March and May. During the yala season it is very difficult to grow the seasonal crops, sesame and finger millet are grown instead.

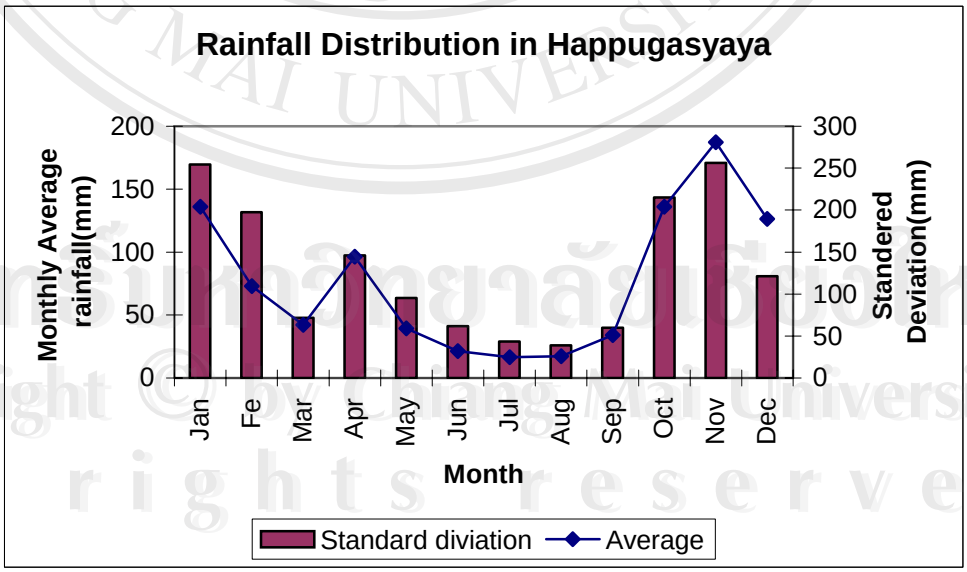

Figure 1.1 Rainfall distributions (1990-2000 years) in Happugasyaya catchments (NRMC, 2000)

4.1.1 Rainfall distribution in Bopitiya Catchments

According to the agro-ecological map of the NRMC, the catchments are belongs to the IM1 (>1400 mm) agro ecological region. These also show the bimodal pattern of the rainfall distribution. During the maha season the highest rainfall of 250 mm occurs in October. (Figure 4.2) This is the worst time regarding the soil erosion when farmers prepare the field for short-term crops. Very dry weather can experience during the months of May-August. During yala season of March-May less than 100 mm rainfall occurs in each month and not enough for the short term crop cultivation.

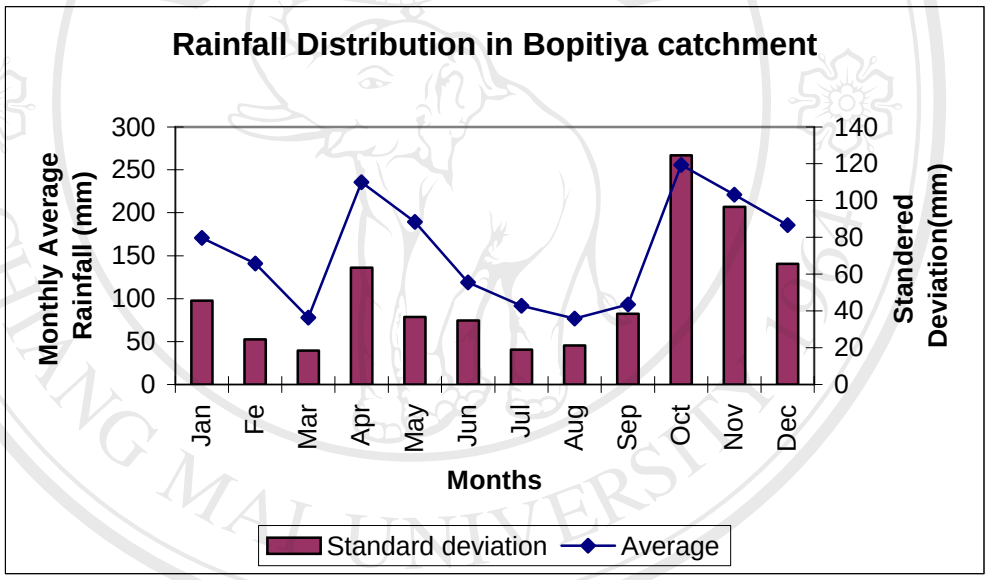

Figure 4.2 Rainfall distributions in (1990-2001) Bopitiya catchments (NRMC 2002)

4.1.2 Rainfall distribution in Maddugalle catchments

This catchment belongs to the IM1 ecological region (> 1400 mm). The rainfall during the maha season is very heavy. The peak rainfall is 350 mm in November and decrease to 300 mm in October and December (Figure 4.3). January and February months receive around 150-200 mm. After the short-term crops are establish drought during the month of November may occur in some years. June-

August is the very severe drought with very heavy winds. During this period they cannot grow any short-term crops.

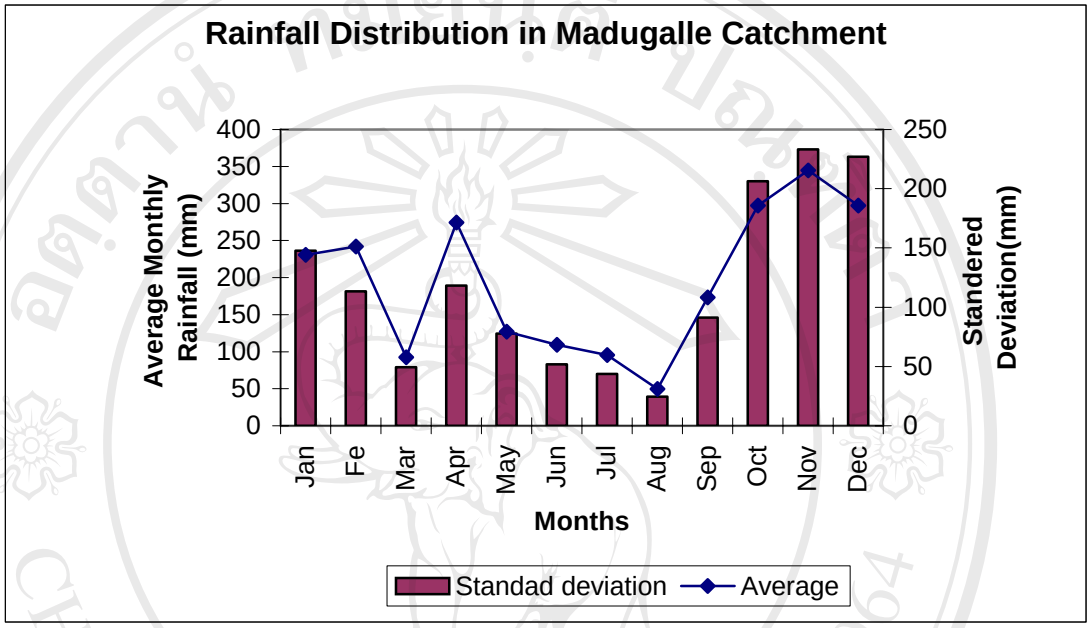

Figure 4.3 Rainfall distribution in Maddugalle catchments between1990-1999

Source: NRMC, 2000.

4.1.3 Rainfall distribution in Siyambalakumbura Catchments

These catchments belong to the IM1 agro-ecological region. The peak rainfall of 250 mm occurs in October month during the maha season, followed by 200 mm and 150 mm in November and December respectively (Figure 4.4). According to the farmers there was not enough rainfall during the last 5 years of period in the yala season. Establishment of SALT hedgerow system in this area is very difficult with the above reasons, but if they do this is a very good relief during the droughts at least they can protect some of the newly planted trees. Another help is the during the drought period they can provide some food from the SALT for the cows and goats.

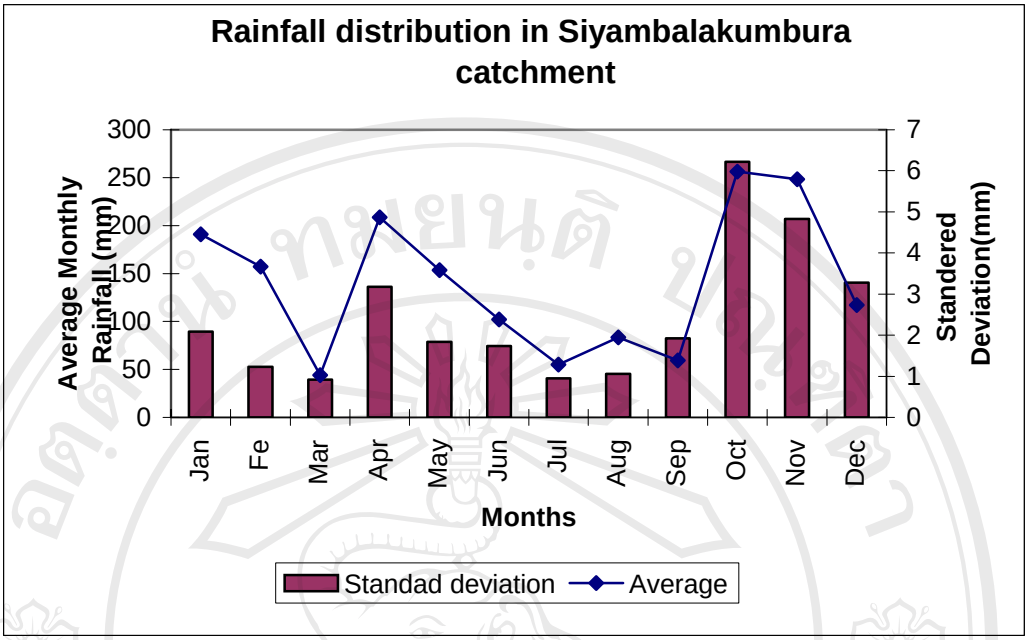

Figure 4.4 Rainfall distribution in Siyambalakumbura catchments between1992-2000 (NRMC, 2001)

4.2 Farmers and land characteristics

4.2.1 Education status of the farmers and adoption

Descriptive statistics of the formal survey shows the illiteracy rate is very low among the farmers in the selected catchments. Only 8% non-adopters and 2.7% of the adopters are illiterate respectively (Figure 4.5). The non-adopters who are literate are 6.7%, and adopters that group 24%.

There are 56% of non-adopters who completed the primary education while the adopters are 65.3%. The percentage of non-adopters who completed the high school and higher education is 12% and 25.3% adopters.

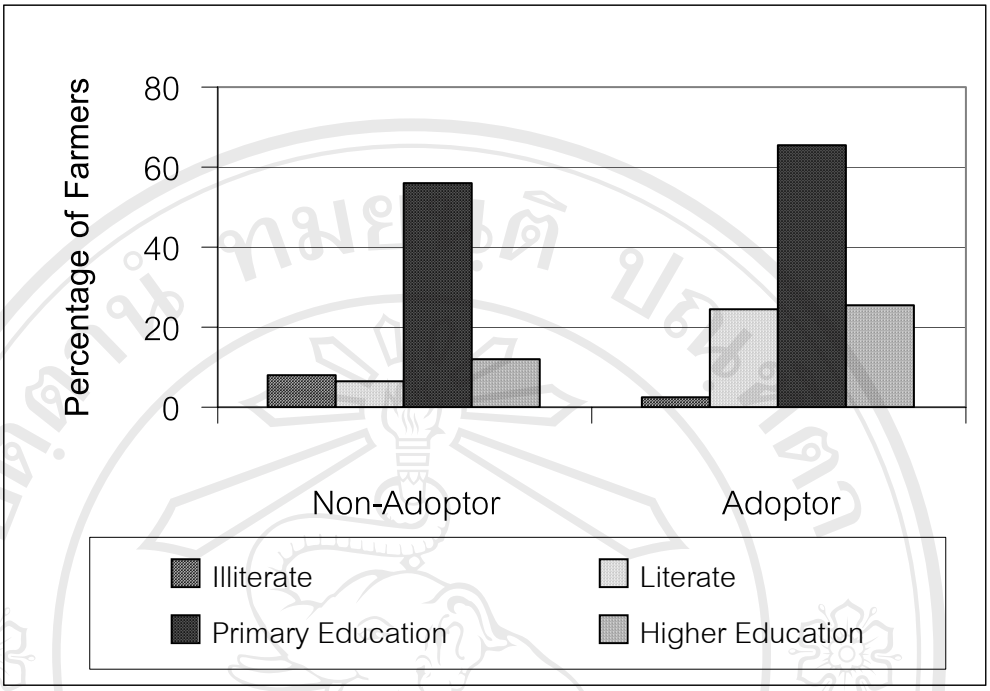

Figure 4.5 Education status of the farmers in the catchments

4.2.2 Skill and adoption of soil conservation measures

Availability of the skilled labor on establishment of soil conservation measures is a main contributing factor to facilitate the adoption. In my research establishment of SALT measure, stone terraces and commonly for all conservation showed the highly significant (1%) difference on skill requirement regarding the adopters and non-adopters (Figure 4.6). But drain conservation does not showed the significant difference. Availability of skilled labor for adopters made them increases the probability of adoption.

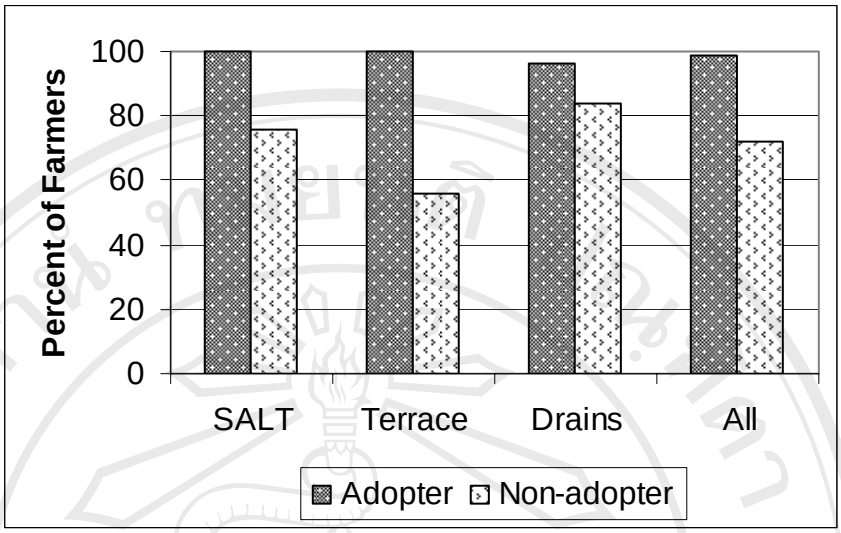

Figure 4.6 Skill on establishment of soil conservation

4.2.3 Land tenure and adoption

Unlike other technologies, adoption of conservation measures highly correlate with the land ownership. Farmers cannot experience the output of conservation measures within shorter period. If the land tenure is not secure there is no incentive for adoption. Regarding the land ownership in these catchments it shows significant difference between the adopters and non-adopters for all conservation measures (Figure 4.7). For own land area it shows highly significant (1%) difference and for the leased land area, the difference is significant at 5% level. There are more adopters who have their own land than non-adopters, but in the leased land area, the numbers for the non-adopters is higher compare with the adopters.

For the stone terrace conservation measure it shows 5% significance difference between the area of own land and leased land area. Under terraces the own land area is higher for the adopters while for non-adopters leased land area is high.

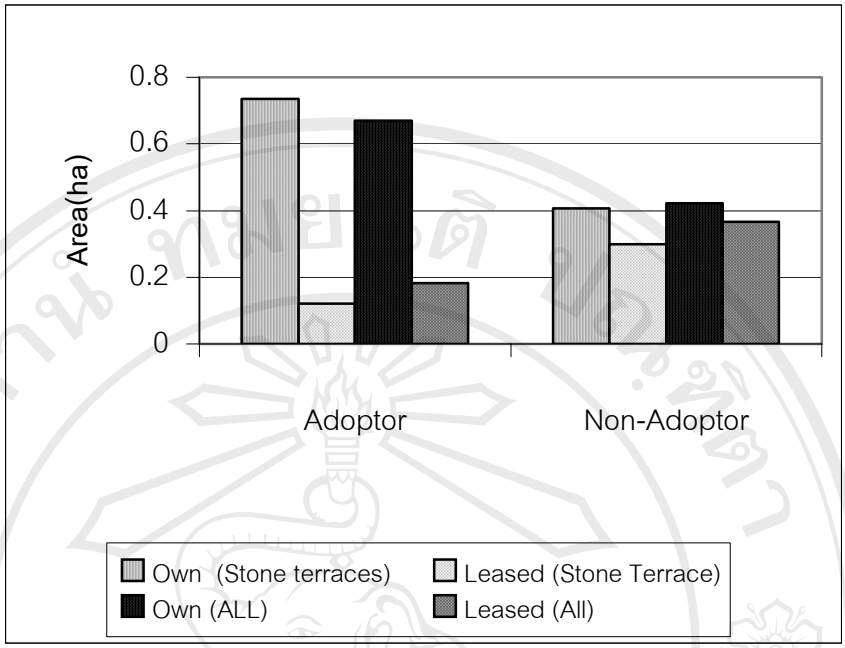

Figure 4.7 Land tenure and adoption for conservation

4.2.4 Length of the stay in the village

This factor is highly correlated with the maintenance of the soil conservation measures. In case of the SALT conservation measure it shows highly significant difference (1%) between adopter and non-adopters. Mean value for duration of stay in the village is 34 and 17 years for adopters and non-adopters respectively (Figure 4.8). In case of terrace conservation measures and for the all conservation measures also it is significant but at 5% level. The non-adopters for terrace, the mean number of years of living in the village are 19 and for the adopters it is 26 years. For the all conservation measures, the mean number of years staying in the village for adopters is 31 years comparing to 24 years of the non-adopters.

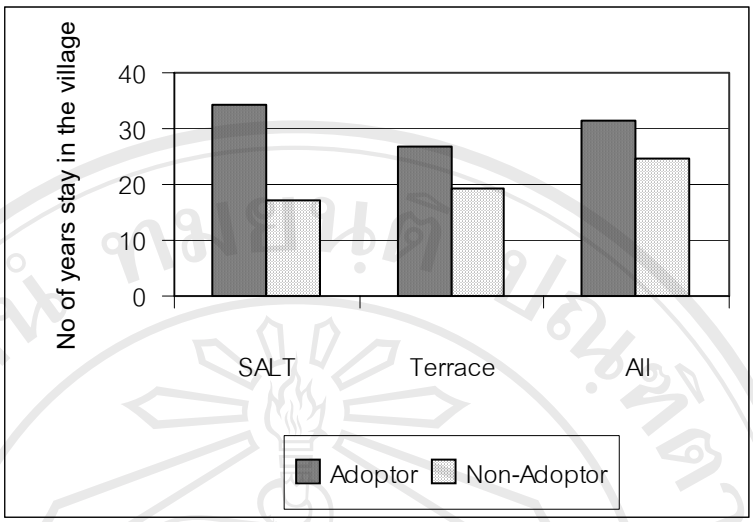

Figure 4.8 .Number of years staying in the village between the adopters and non-adopters of different conservation measures

4.2.5 Technical assistance and farmer participation

Technical assistance and training methodologies use for the farmers and training of trainers regarding the soil conservation measures is a very important aspect.

Regarding the stone terrace soil conservation measure and for all conservation measures the higher participation in the training by adopters has been found comparing to the non-adopters (Figure 4.9).

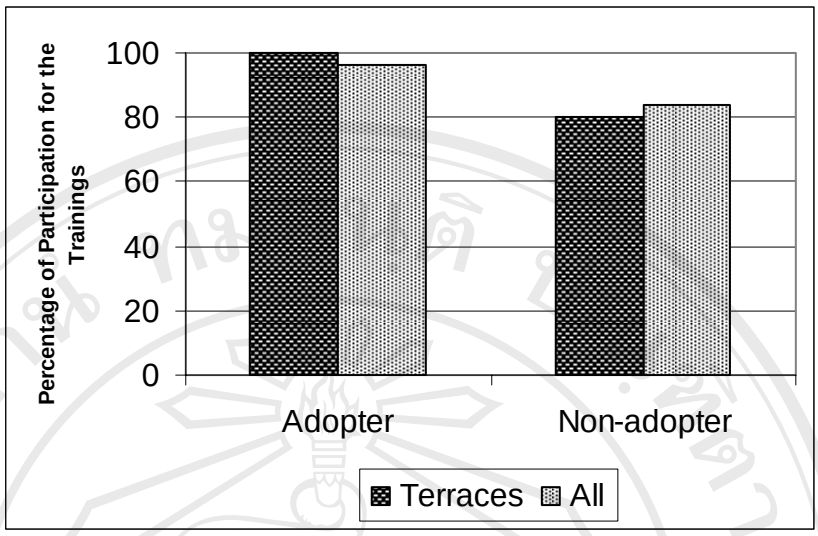

Figure 4.9 Farmer participation for the programs

There were complaints regarding the technical officer, for not providing the technical assistance, at all on at the exact time it needs. Another important constraint is method of training. As it is mentioned in the methodologies and cases cited in literature review, the soil conservation technology offered to the farmers has to be attractive, because the impacts of conservation cannot be tangible within one season of its adoption.

Methodologies used by technical officer are very important. The farmers especially the tenants farmers are risk averse compare with farmers who have their own lands. The tenant farmer's objective for farming is optimum profit with little investment in land improvement. The soil conservation demonstration was launched by NRMC from 1999-2001 in Maddugalle, in year 1999 there were only 50 farmers participated but the number was increased up to 70 in year 2000, and 120 farmers joined in 2001.

Conservation of this environment not only proper soil conservation measures for the vegetables but also the fruit development program with soil and moisture conservation technologies by microenvironment development were introduced for the farmers. During the first year it started with 10 farmers. The fruits introduced were improved varieties of mango, oranges, lime, pineapple, banana, ambarella and guavas.

Pineapple was established through the contours (same way of Vetiver grass strips). In year 2001 program the number of farmers were increased up to 30 with limited budget. With the techniques of soil conservation, pruning and training technologies of fruit plants, pest and diseases control technologies also introduced. Now some trees are bearing the fruits and they were well accepted by farmers. It is possible that the new watershed management program can introduce an extension package with some kind of forest trees in order to conserve the area.

4.2.6 Access to technical assistance

If a farmer has a problem regarding the contact with the technical officer, the adoption of soil conservation measures is poor. In case of SALT it shows highly significant difference (1%) between the adopters and non-adopters regarding access for technical assistance (Figure 4.10). For all conservation measures also show the significant (5%) difference between adopters and non- adopters.

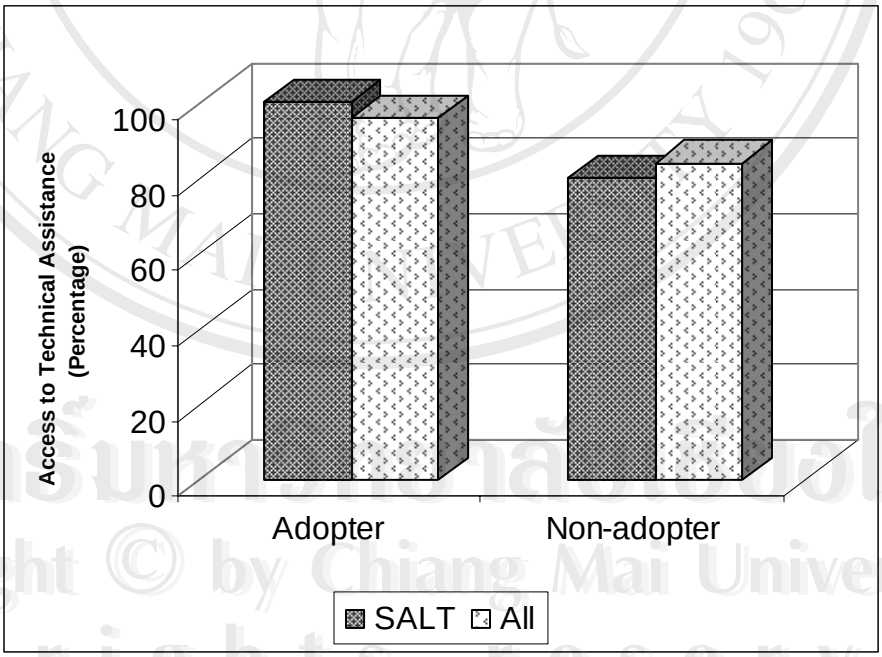

Figure 4.10 Access to technical assistant of soil conservation

4.2.7 Slope classes of the lands and the adoption

The average slope in the catchments was divided into three classes. The lower slope class is 0-15% (class1), the moderate slope class, 15-30% (class 2) and the higher slope class, > 30% (class 3). According to the cross tabulation results on slope classes and adoption 13.3% of non-adopters are in slope class 1, 50% of non-adopters are in slope class 2, 36.7% of non-adopters are in slope class 3 (Figure 4.11). For the adopters, 21.7% of them are in slope class 1, 51.7% in moderate slope class and 26.7% of them are in the higher slope class.

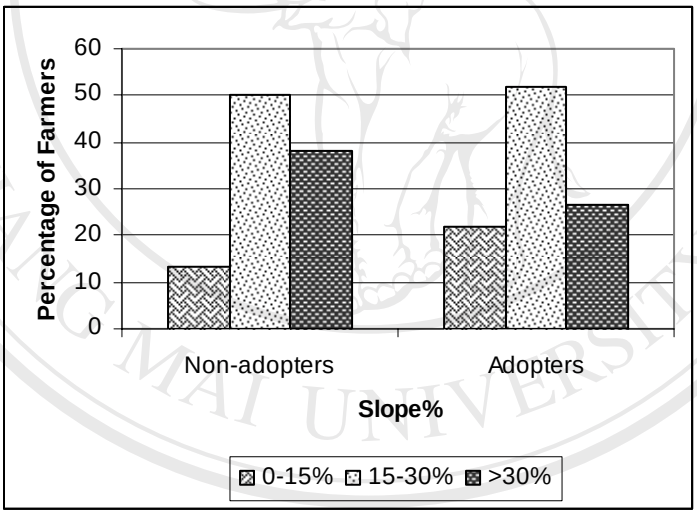

Figure 2.11 Slope Classes and Adoption

The homesteads are normally confined to the lower elevations. Moderate slopes and higher slopes are the cultivated lands.

4.2.8 Slope and adoption of SALT

Cross tabulation among the slope classes and the adoption of SALT show that 13.3% of adopters' lands are in the lower slope class, 50% in moderate class and 36.7% are in the higher slopes respectively (Figure 4.12). The non-adopters lands in lower slope class is 2%, in moderate class is 30% and 68% in the higher slopes respectively. The results show higher adoption in moderate and lower slope classes. There are more non-adopters in steep slopes than adopters.

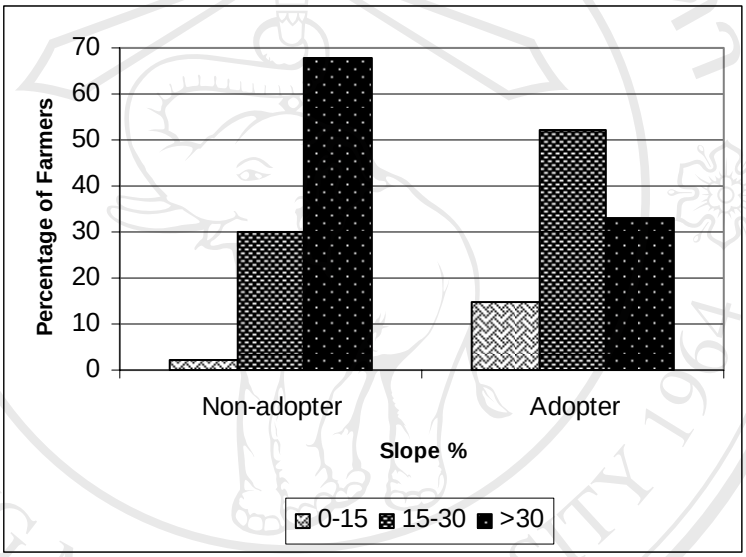

Figure 4.12 Adoption of SALT among different Slope classes

4.2.9 Land productivity change during 10 years period

The productivity of the lands of the adopters according the farmers shows the significant difference (1%) to non-adopters lands. Within the adopters 26.7% of farmers' lands productivity has increased, 20% of their lands productivity has decreased and 33% of their lands productivity has not changed (Figure 4.13).

Non-adopters stated that in the non-adopters lands, 36% of their lands productivity has decreased, 10.7% of their lands productivity has increased and 33% of their land productivity has no change during the 10 years of time period.

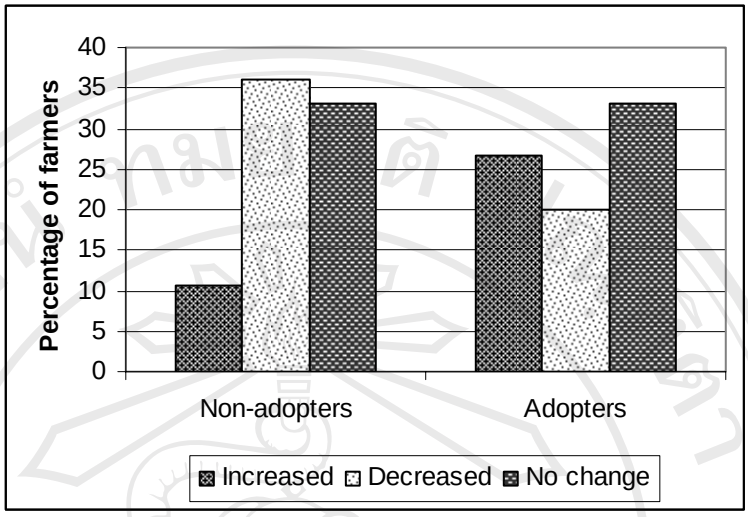

Figure 4.13 Land productivity changes of the adopters and non-adopters lands within 10 years period

4.2.10 Status of soil fertility

The fertility in the adopters and non-adopters lands is divided into three groups as fertile, moderately fertile and not fertile. From the adopters they stated 50.7% of adopters lands are fertile and 18.7% of non- adopters' lands are fertile (Figure 4.14). Moderate fertility could observe in 56% of adopters lands while 46.7% non-adopters lands were moderately fertile. Poor fertility of land was observed in 25.3% of non-adopters lands and 2.7% for adopters' lands. Commonly the adopters' lands are more fertile than non-adopters.

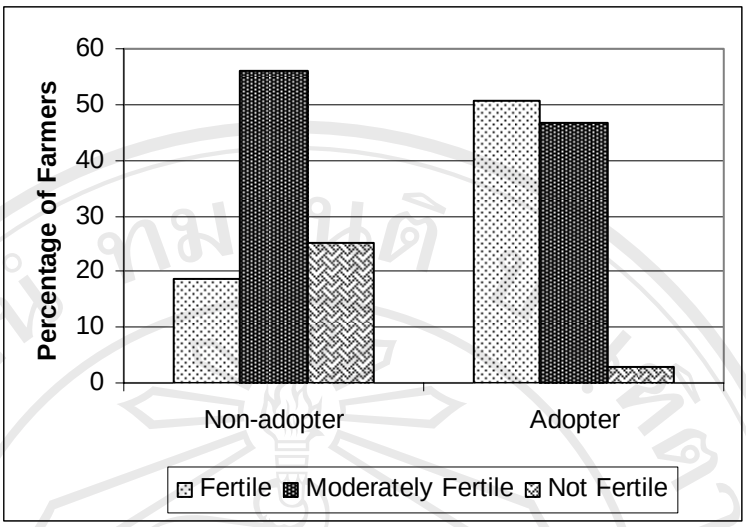

Figure 4.14 Status of soil fertility in the farmer fields

4.2.11 Soil fertility change during 10 years period

From the adopters 40% of the adopters stated that soil fertility of their land has increased during the past 10 years (Figure 4.15), 33% of the adopters' indicate that their lands fertility has decreased and 27% of the adopters responded that there is no change in soil fertility in the lands.

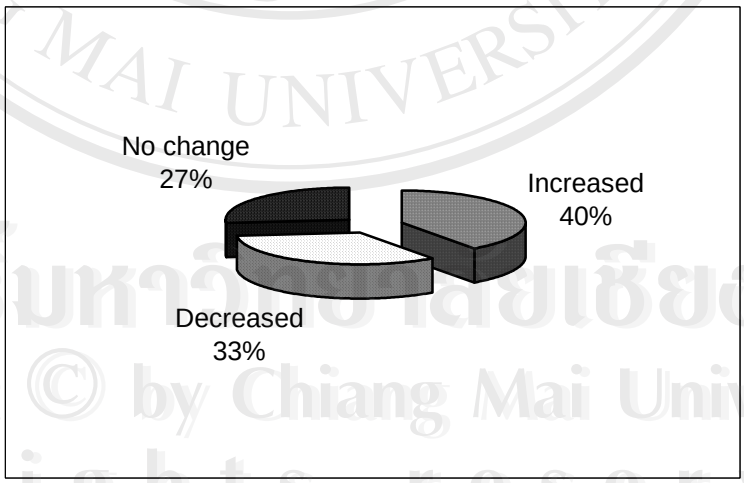

Figure 4.15 Soil fertility in adopters land during the past 10 years

In case of non-adopters (Figure 4.16) 65% of them responded that their lands soil fertility has decreased, 19% responded as increased while 16% of them responded that there was no change in soil fertility respectively.

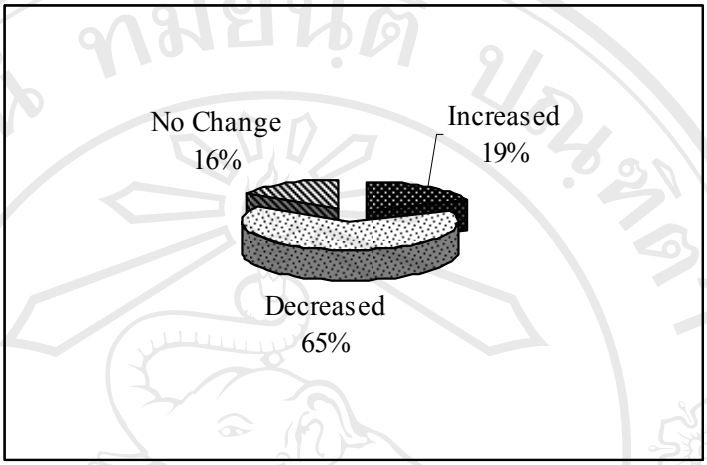

Figure 4.16 Soil fertility change in non-adopters Lands within 10 years of period

4.2.12 Soil fertility management techniques used by farmers

Soil fertility management techniques are very important to improve degraded lands. In the study area several kinds of fertility improvement techniques are used by farmers.

In adopters' lands, 58% of them applied organic manure 13% of them practice mulching, 5% of them do crop rotation and 24% of them did not practice any of those techniques to improve the fertility (Figure 4.17).

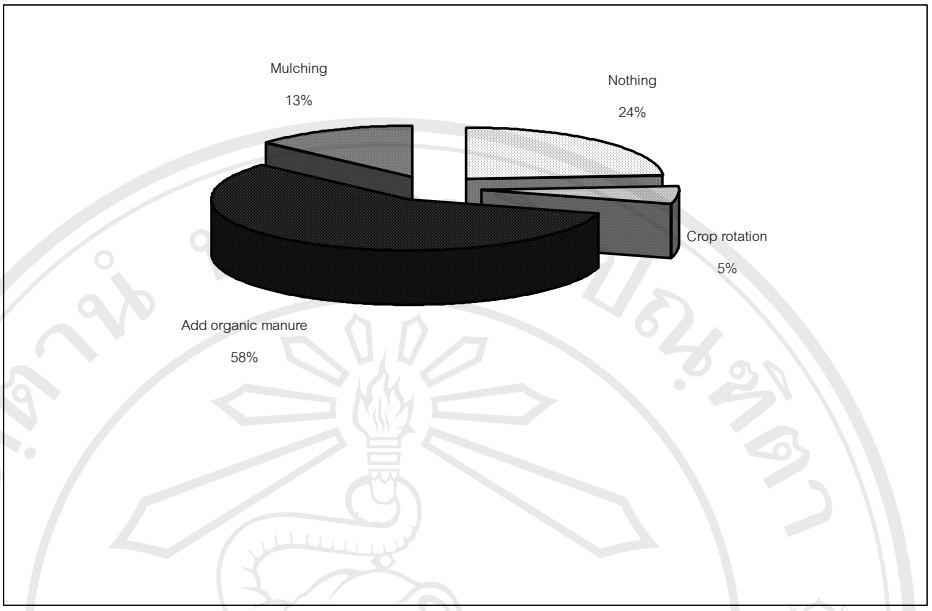

Figure 4.17 Fertility management practices used by adopters

In non-adopters lands 46% of the farmers do not use any fertility improvement method. About 44% of them use organic manure, 9% of them practice crop rotation and 1% of them are practice mulching (Figure 4.18).

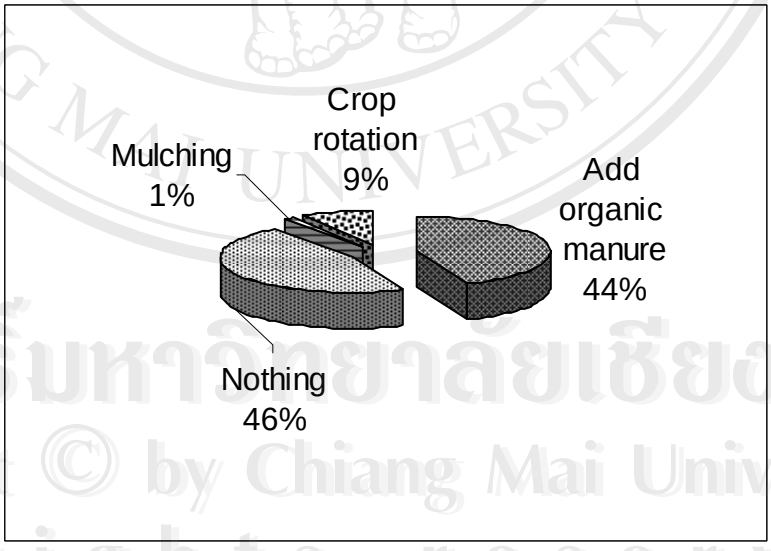

Figure 4.18 Fertility management techniques use by non-adopters

4.2.13 Farm labor availability

Availability of family labor is a very important factor on adoption of soil conservation technology. Especially in case of short-term crops most of the soil conservation measures have to establish during the same period when farmers cultivate their crops. During the establishment period of SALT and contour drains adequate soil moisture is required. During this critical period their main focus going to crop. In case of leased holders they cannot do any work on establishment of conservation measures during off seasons because they are not allowed to enter the lands. For all conservation measures in selected watersheds it shows the significant (5%) higher family labor units available for the adopters comparing to the non-adopters (Figure 4.19). But there is no significance different of labor availability between the adopters and non-adopters for SALT, Terraces, and for Drains conservation measures.

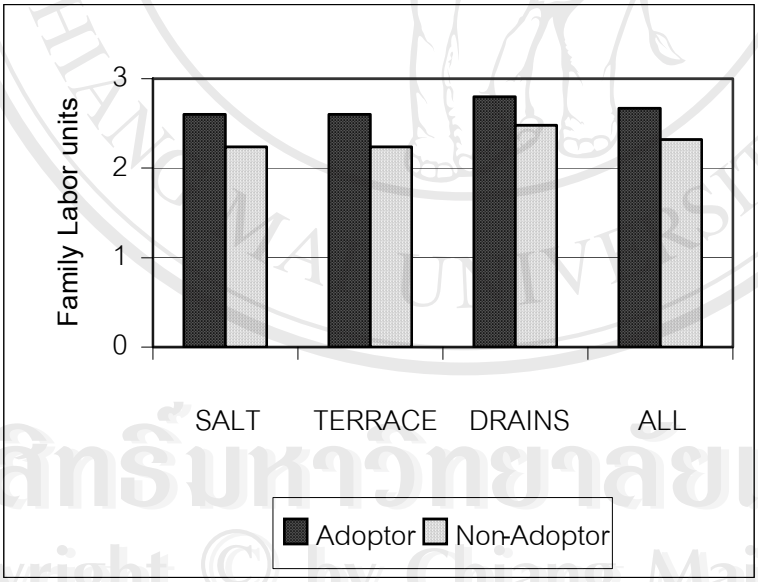

Figure 4.19 Family labor availability

4.2.14 Crops grown by adopters and non-adopters

In these watersheds, relatively high proportion of the areas were used by non-adopters for vegetable crops (mean of 0.6ha/farmer) (Figure 4.20), while the adopters grow more field crops (mean of 0.18 ha/farmer) such as chili, sesame, finger millet and some other pulse cover crops (ex: kollu /horse gram) which are necessary for household consumption through out the year. The growing area of tobacco is almost the same by adopters and by the non-adopters (mean of 0.10 ha/farmer) due to its high value and stable price. Small amount of perennial crops are grown in the zone.

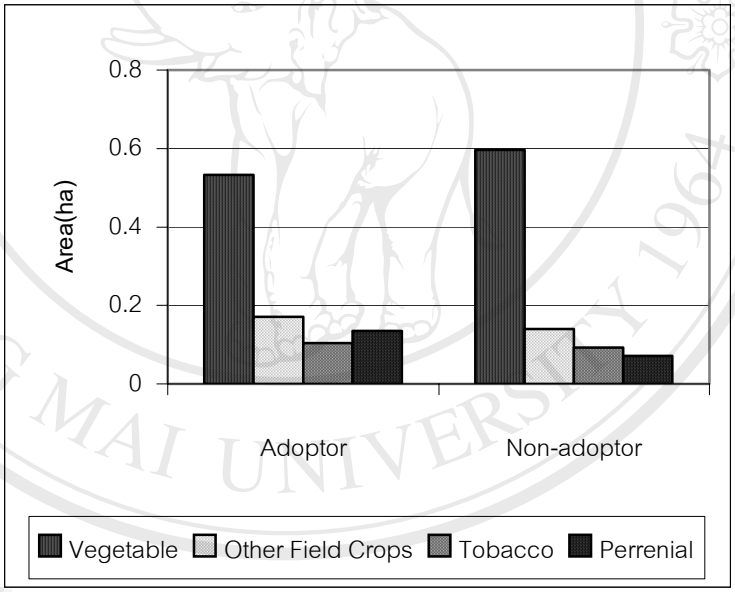

Figure 4.20 Area of the different crops grown by adopters and non-adopters

4.2.15 Incentives received and preference

Starting of the rainy season (maha) farmers have to depend on various sources to purchase their inputs. Preference for the incentives is very important because it is related the farmers problems what he face during the farming season.Within the adopters 20% receives cash as incentives, but 25% of adopters prefer cash. (Figure 4.21) Within non-adopters 32% receives the inputs but 53% of them prefer to have

inputs. In case of adopters 38% receives the inputs but 61.3% of them prefer the inputs as incentives. Most of the farmers in these catchments are willing to have inputs for the farming. Farmers who don't have the adequate family labor units are willing to have cash as incentives. Women like to have inputs than cash.

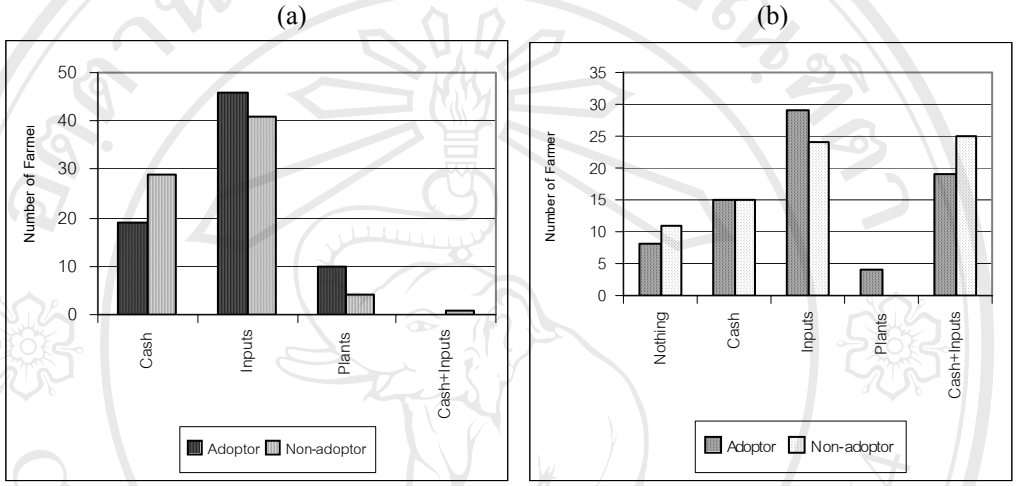

Figure 4.21 Incentives receive (a) and preference (b) of adopters and non-adopters

4.2.16 Attitude towards conservation and adoption

The farmers' attitude towards conservation is very important factor for adoption. The programs for attitude development of the farmers have been developed to limit the farmers' free time to attend. If those programs are plan during the off-season it is easy for them to participate for those programs.

Mean comparison among farmers attitude for SALT, Terraces, and for all conservation measures showed the highly significant difference (1%) among the adopters and non-adopters.

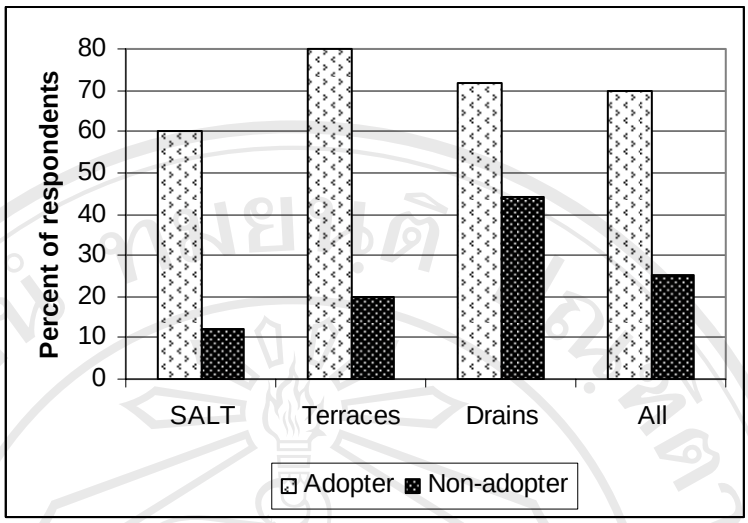

Figure 4.22 Attitude and adoption on conservation

In all conservations the mean for adopters having positive attitude towards soil conservation is 70% and mean for non-adopters having positive attitude towards establishment of soil conservation is 25% (Figure 4.22). For the SALT the mean of having positive attitude for adopters is 60% and mean for the non-adopters is 12%. In stone terrace conservation mean to having positive attitude for adopters is 80% and for the non-adopters it is 20%.

4.2.17 On-farm income and the adoption

Mean comparison of the on-farm income shows non significant difference between the contour drains and SALT conservation measures. For the all conservation and terraces it is significant (5%) among the adopters and non-adopters. Especially from the graph it is clearly seen that the farmers whose on-farm income are lower are not going for the high costing mechanical soil conservation measures. That is easy for him to choose the low cost soil conservation measures like SALT (Figure 4.23).

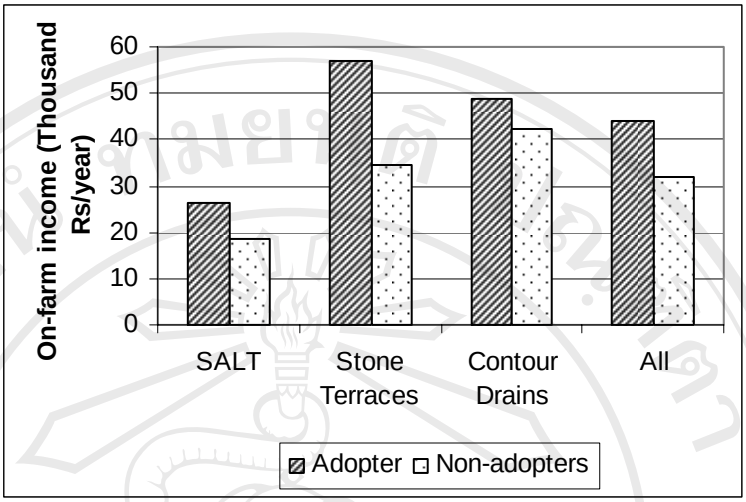

Figure 4.23 On-farm income and adoption of conservation measures

The farmers, who have high on-farm income, are willing to invest on long-term conservation measures like stone terraces and contour drains.

4.2.18 Off-farm income and adoption of soil conservation

Off-farm income is another contributing factor on adoption of soil conservation. This can supplement the on-farm income due to uncertainty of farms income causes to several reasons such as crop damages from the wild animals, droughts, and pest and diseases problems.

Farmers earn the off-farm income from working in the garment factories and working in the cities. There was highly significant difference in the off-farm income between the adopters and non-adopters for contour drains (1%) while it is not significant in case of SALT and terraces. For the all conservation measures it is significant in 5% level.

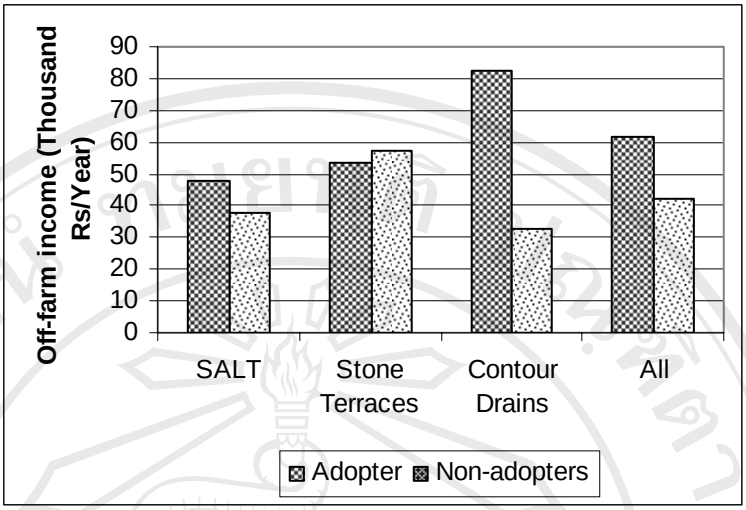

Figure 4.24. Off-farm income and adoption

The results also show that when farmers receive higher off-farm income they invested in the more expensive conservation measures. If the off-farm income is low he chooses the low cost conservation measures like SALT.

4.3 Mind maps

Mind maps were constructed to gain an inside about soil erosion status and perception on conservation of adopters and non-adopters, and also to find out the reasons why they adopt or non-adopt of SALT, stone terraces and contour drains by farmer participatory approach. Mind mapping for adoption of the conservation measures were done according to the moderate and steep slope lands separately.

Farmers were actively participated in the workshops for creating the mind maps, in some cases they were arguing to find out the correct answer. They really aware about the soil erosion problem and they know they have to do it well.

However, yield data, on-farm and off-farm income, and the information about the credit were very difficult to collect. Most of the farmers were reluctant to say about the credits that they have taken from the out side. They were very proud and did not like to say their difficulties in public. Those are cultural issues as I noticed during my work. Incase of income they did not tell the truth. So that several kind of questions had used to collect the data.

Another interesting issue was on the incentives received and the preferred incentive to be received. Women came forward and talked on the inputs required but not in front of their husbands. Women were of the notion that the husbands normally waste the money if received in cash. However, female headed households preferred to have cash in hand so that it could be used to pay for hired labor.

4.3.1 A Mind Map of SALT on the Steep Lands

The non-adopters mentioned about the difficulties in maintaining SALT during off seasons and during the heavy wind with drought. It was found that the main problem was the lack of labor during planting seasons and most of the non-adopters believed that SALT hedges uptake more water from the land. Other problems found were fewer amounts of incentives and difficulty in handling SALT on the steep land. (Figure 4.25).

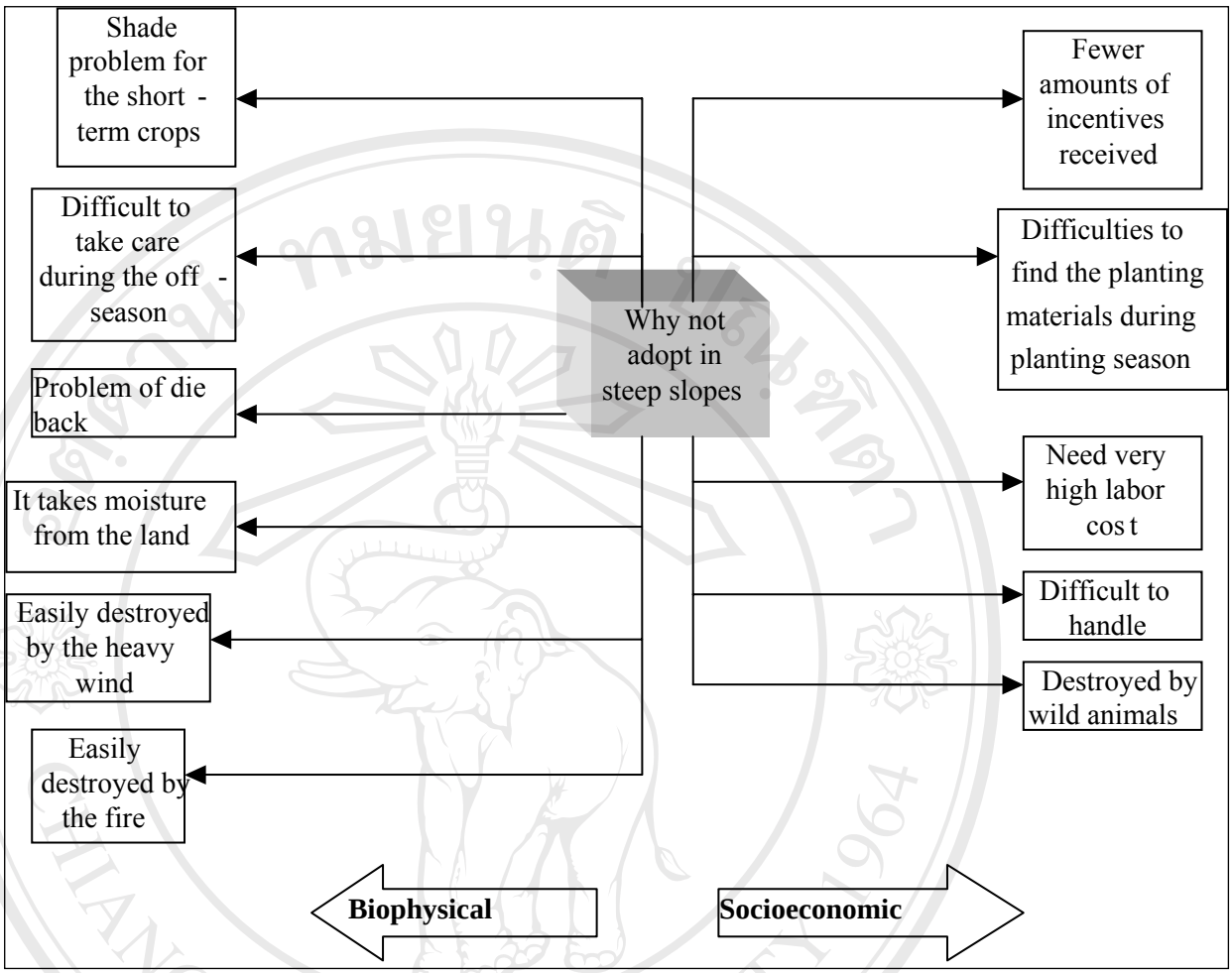

Figure 4.25 Mind mapping on the reasons for not adopting SALT in steep slopes

The adopters of SALT conservation measure on steep slopes prefer to have it as a barrier for the run-off, also as for extra income source for the household by selling bean sticks. The tenant farmers like to establish the SALT in their plots because it is not costly to establish and maintain as compared with other mechanical conservation measures. Other reasons for adoption are the use as mulch, organic manure, and as an animal food (Figure 4.26).

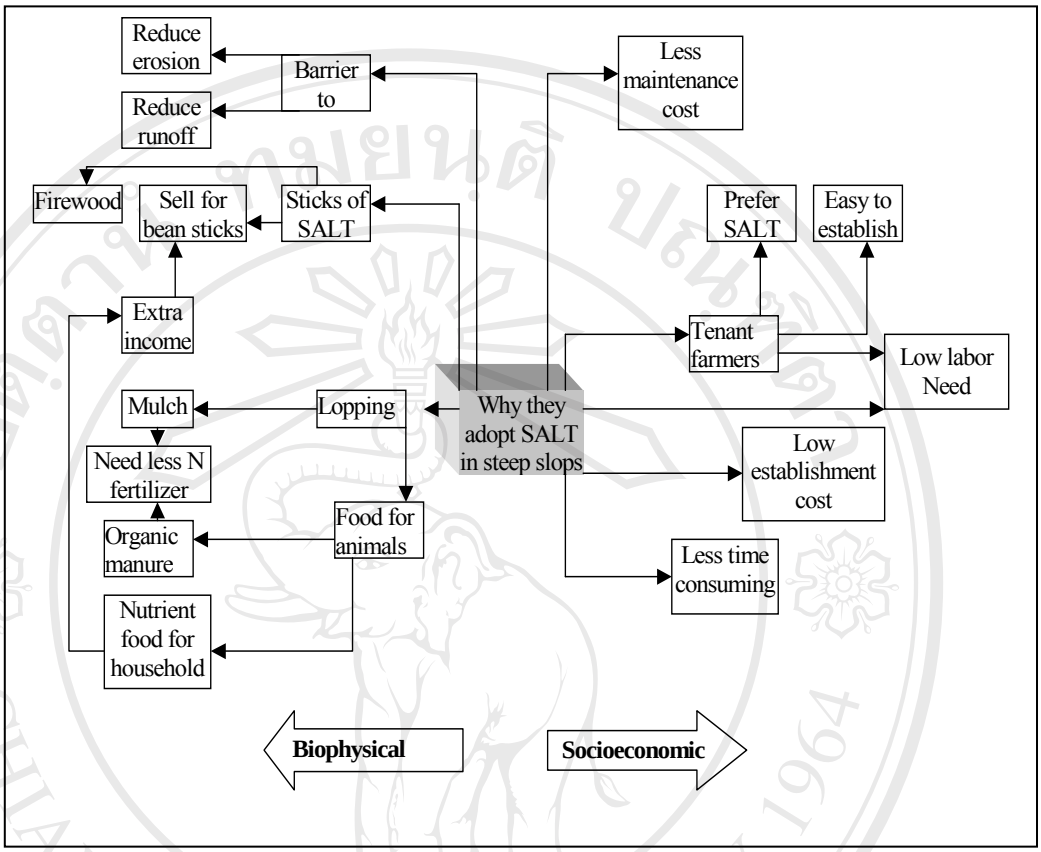

Figure 4.26 A mind map for adoption of SALT conservation in Steep lands

4.3.2 Mind map of SALT on the moderate slopes

On the moderate slopes tenure problems, labor problems, low income, lower amount of incentives and difficulties to work with 'A' frame were causes of the constraints of adoption of adoption SALT (Figure 4.27). The amount of incentives paid for one meter of SALT is only 12 Rupees, this amount is too small to encourage the establishment of SALT. Most of elder farmers did not like to use 'A' frame to mark the contour lines. The problem of rats and termites with SALT mulch was another important problem they faced. Rats destroyed the carrots, pumpkins and corn, while termites easily spreaded within the mulch of SALT and attack the bark of the Gliricidia sticks and sometimes damage the crops plants. When SALT hedgerows died back farmers do not usually refill the gaps.

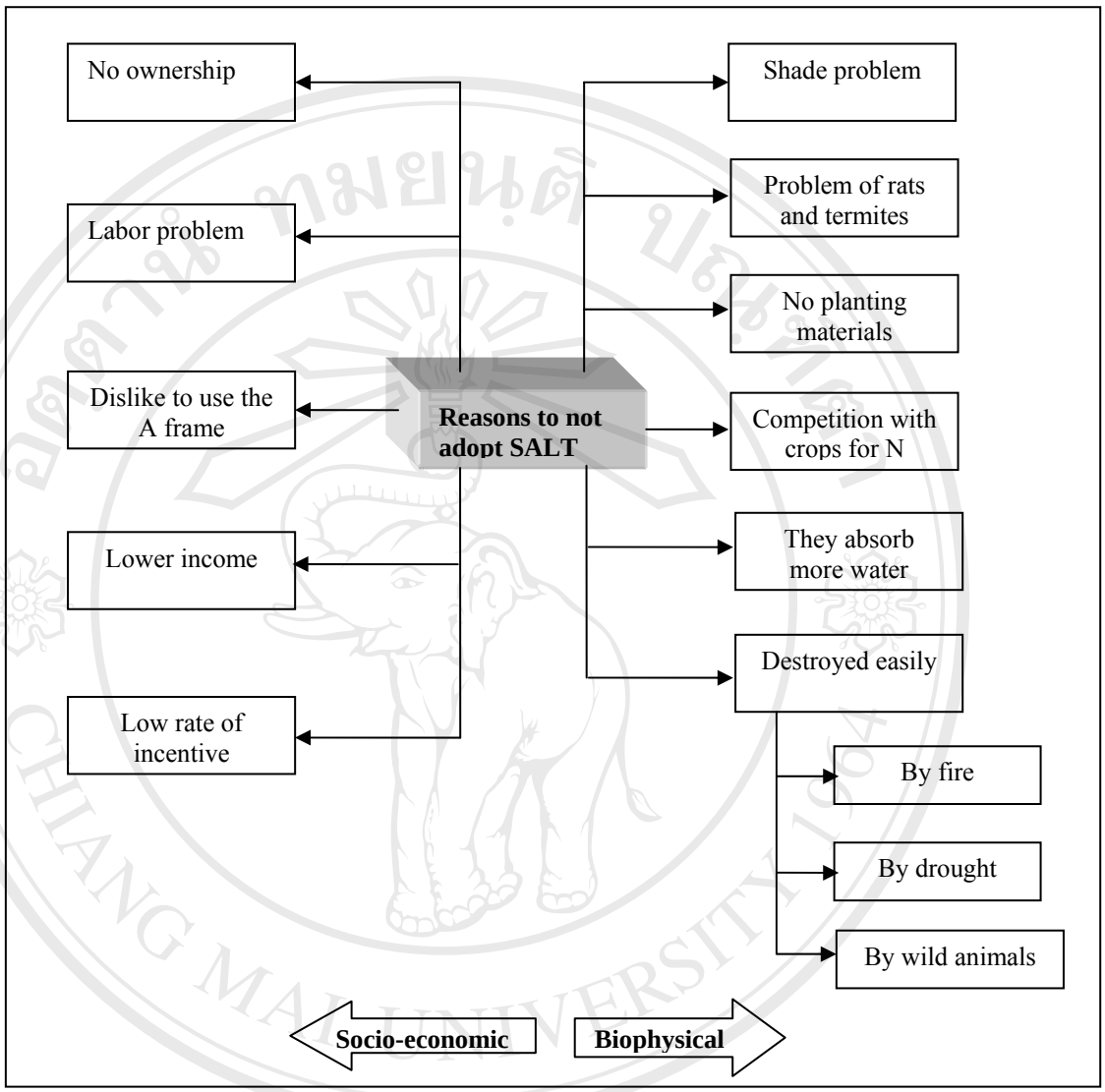

Figure 4.27 A mind map on reasons to not adopting SALT in moderate slopes

Some farmers believed that SALT hedgerows uptake more water and more nitrogen fertilizers that they apply for the crops. Farmers concerned about the difficulties of finding out planting materials during the planting period and the problem of the shading of SALT hedgerows to the cash crops. Other reasons were dying back of the hedgerows during the off-seasons, damage caused by wild animals, drought and fires.

The adopters of SALT in moderate slopes prefer SALT because it needs less labor for construction and maintenance. It has low cost and women can easily

construct this in moderate slope lands. SALT is a good animal food source; it conserves soil moisture and improves the soil structure and fertility. Compared with other conservation measures, SALT takes less time to establish (Figure 4.28).

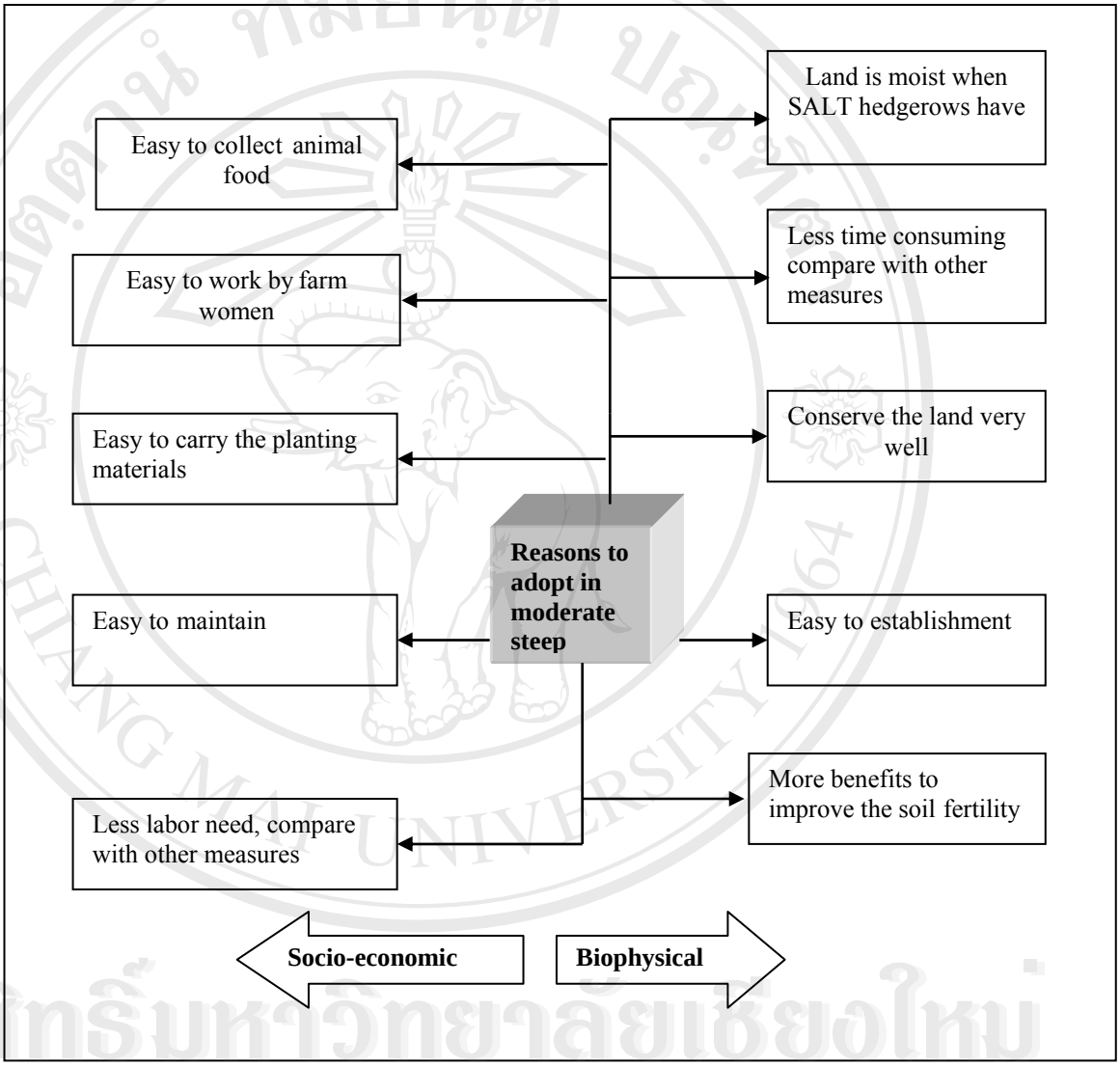

Figure 4.28 A mind map on reasons to adopt SALT in moderate slopes

4.3.3 A Mind map of stone terraces in steep slopes

According to the adopters of stone terracing on the steep slopes, stone terraces are more stable for the steep slopes, against the heavy rains. It is easy to work on the terraces after plant establishment. Farmers who grow annual crops prefer stone terraces to SALT.

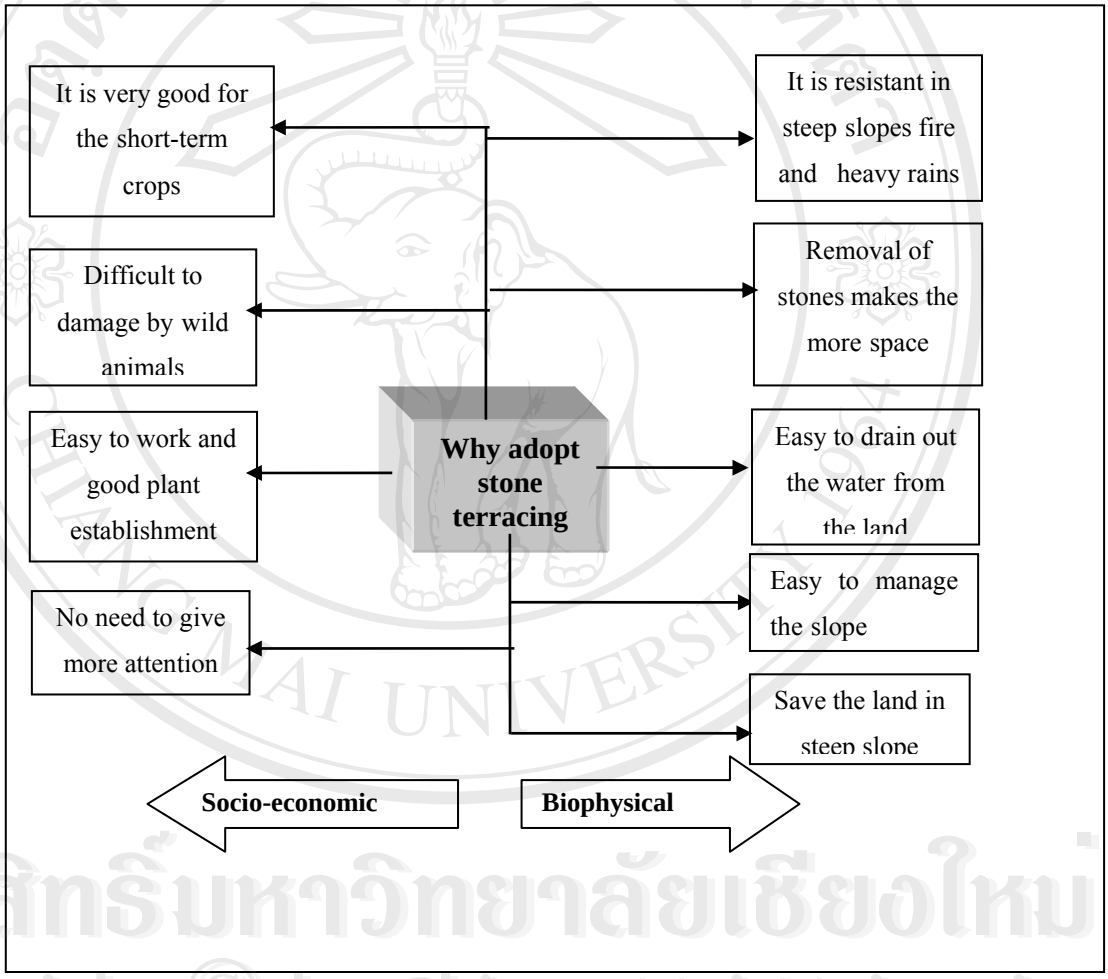

Figure 4.29 A mind map to reasons to adoption of stone terracing in steep slopes

There is no shade problem by stone terraces and need less attention after the establishment of stone terraces, therefore it is a good long term investment for conservation measure (Figure 4.29).

Stone terraces cannot be damaged easily by the wild animals and they are resistant to the fire. Farmers also gain more space in the land by removal of the stones to establish of the stone terraces. It easily drains the water from the land without eroding the soils and it reduces the rate of run-off. The stone terraces protect the land well from erosion and other damages mainly by wild animals.

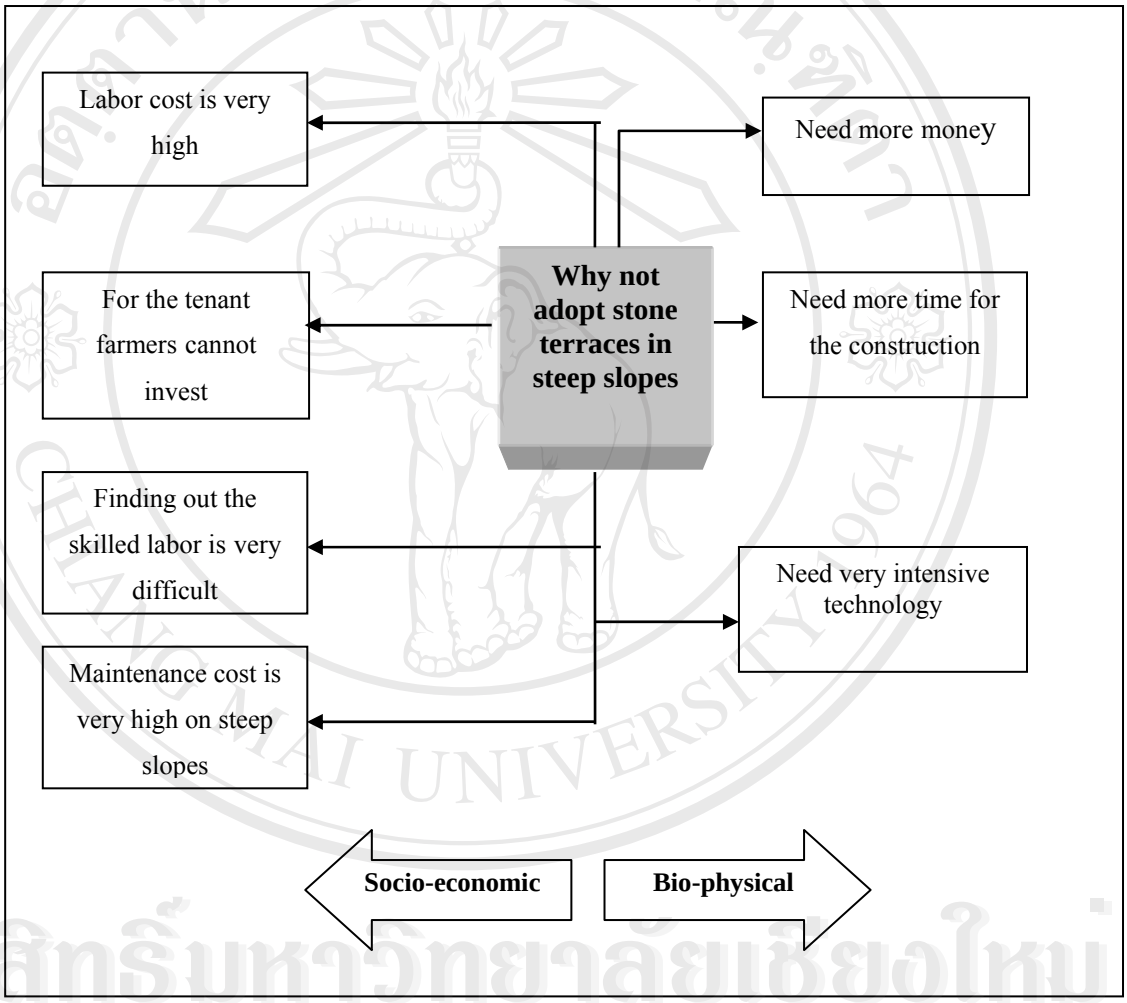

Figure 4.30 A mind map on non-adoption of Stone terraces in steep slopes

According to the non-adopters, land ownership is a main problem for the adoption because it needs more money for constructions, and labor cost is also very high in steep slopes due to time consuming in constructions (Figure 4.30). In addition, the incentives from the government or non-government agencies also require proof of the ownership of the land when they pay for the constructions.

Farmers need much knowledge and technology to construct stone terracing in steep slopes. Whether some time they have learnt from the training programs about the constructions it is not easy thing to do without having any experience. Availability of the skilled labor during the construction period is very rare because everybody tries to finish the constructions in time.

4.3.4. A mind map of stone terraces on moderately steep slope

Under this condition farmers prefer to establish the terraces because the investment is worthy and it is a long time investment. There is no special attention after establishment like SALT and contour drains. They can get higher amount of incentives as compare with other soil conservation measures. They can start the construction or maintenance work before the starting of land preparation, because for construction there is no needed to have rainfall, and then there is no overlap with the planting time (Figure 4.31). Hence, they may not face the labor scarcity problem. Stone terraces can also protect the crops from wild animals, and removal of stones from the land for the construction of stone terraces makes more space for the planting of crops. They prefer it because it saves the land from erosion and it is resistant to heavy run-off during monsoons.

The non-adopters of stone terraces in moderate slopes mentioned that the incentives they receive for the construction of stone terraces are not adequate compared with the amount they spend for the construction (Figure 4.32). If they have to hire the skilled labor, then the expenditure becomes double.

According to the non-adopters, the construction of stone terraces is hard working. It needs more skilled labor and it is time consuming for the construction. Compare with the other conservation measures, it take more space from the land for the construction. If farmer have very little land area, spending of more area for this technology is not good for farming.

The tenant farmers cannot spend more for the construction of conservation because that investment goes to other people and they can not receive the incentives for the construction.

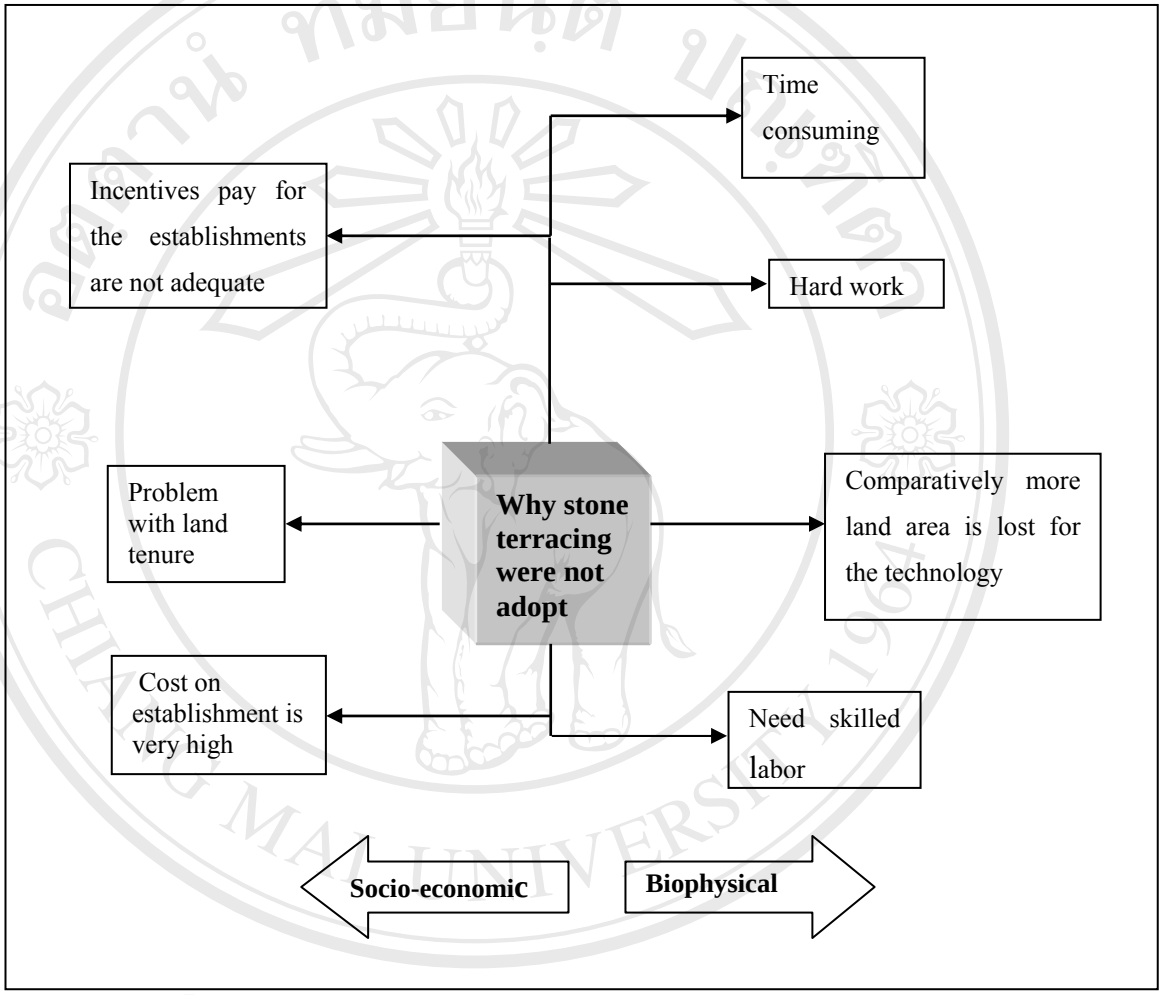

Figure 4.31: A mind map Reasons for non-adoption of stone terraces in moderate slopes

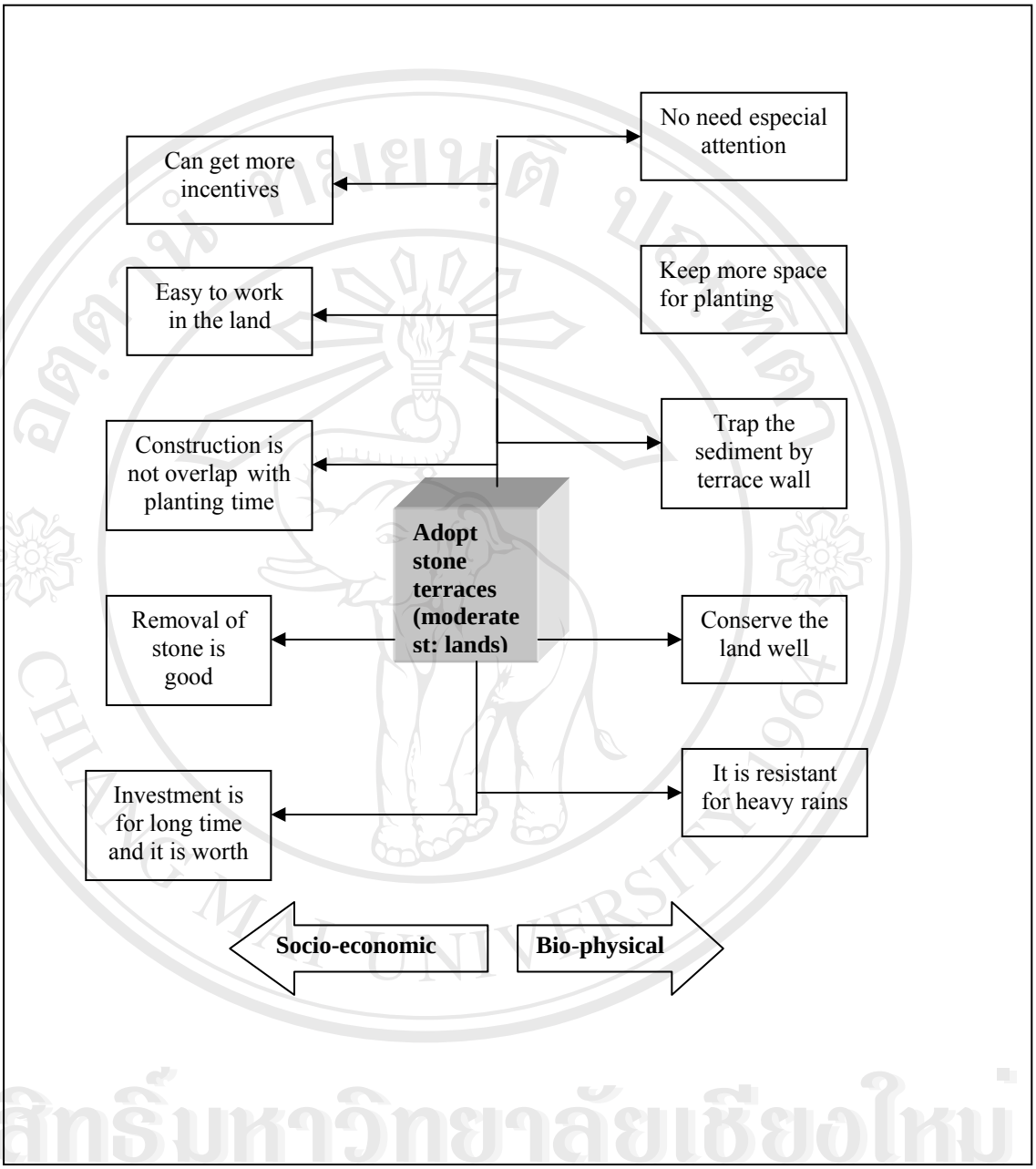

Figure 4.32: A mind map on reasons to adopt stone terraces in moderate slopes

4.3.5 A mind map of contour drains in steep slopes

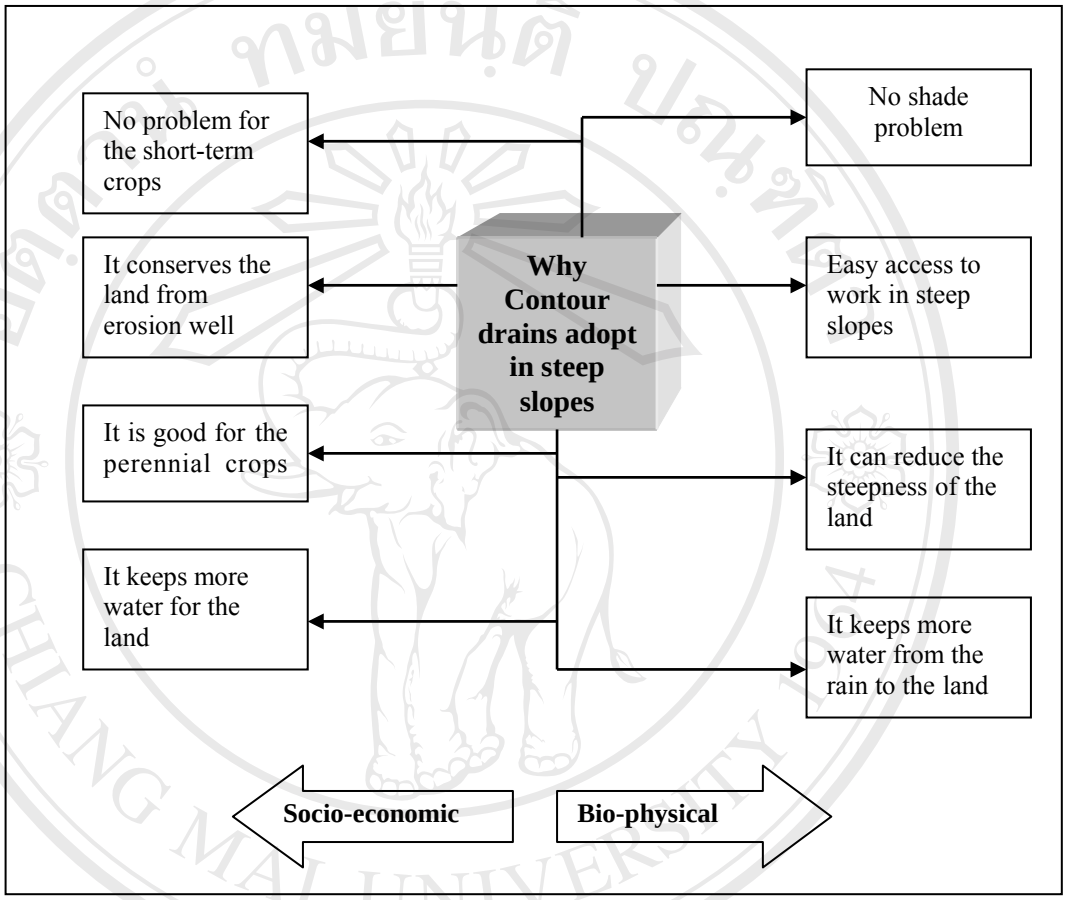

Figure 4.33 A mind map on reasons to adopt contour drains in steep slopes

The adopters of contour drains on steep slopes are keen on soil and water conservation. Some of the short term crop cultivators especially tobacco cultivators prefer to have contour drains and stone terraces than SALT, to keep the land free of other covers (Figure 4.33). Those who have perennial crops cannot construct the SALT because the hedgerows cannot survive under the shade. Especially those who are doing export crops like pepper, coffee, nutmeg, and cloves like to construct contour drains because some of the export crops are very sensitive for the water stress. If land is with contour drains can help store soil water for a longer time.

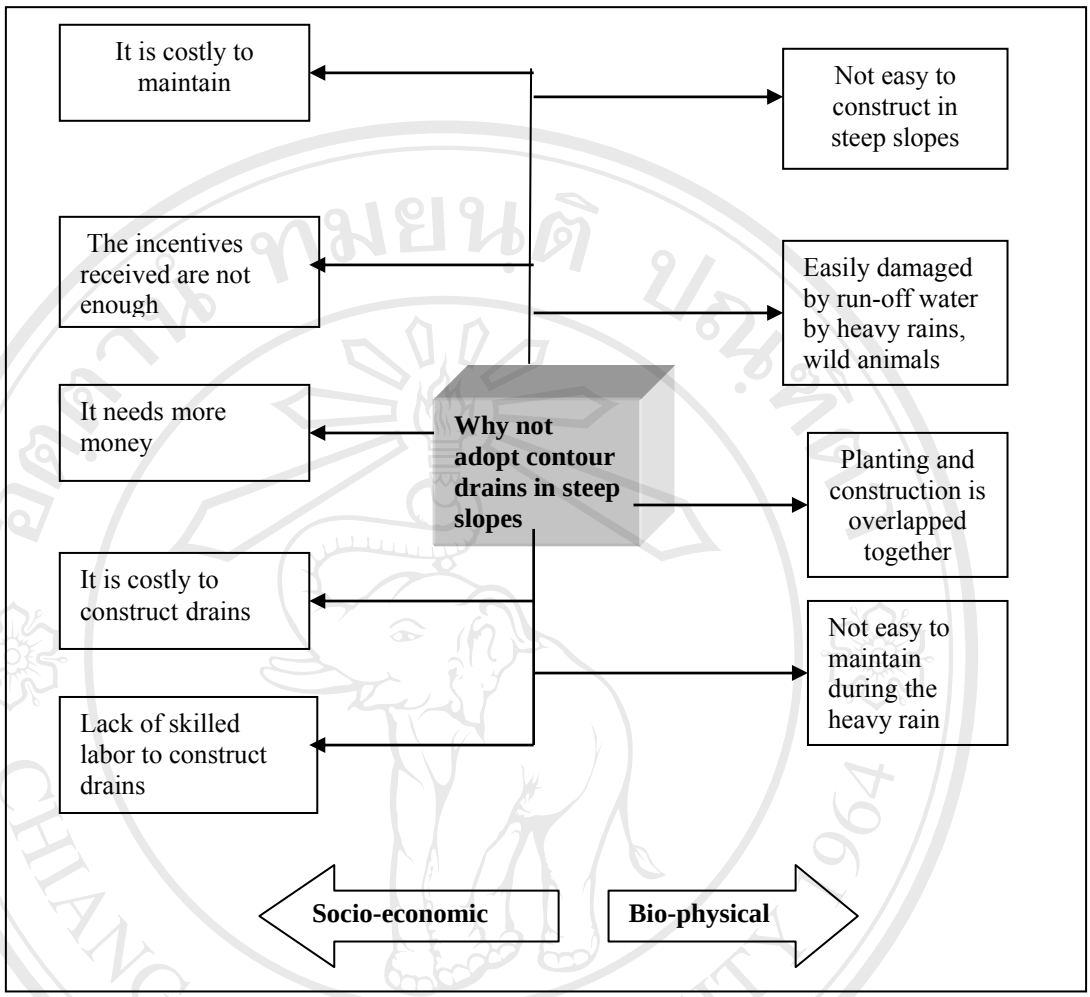

Figure 4.34 A mind map on reasons to non-adopt contour drains in steep slopes

Non-adopters usually complain about the high cost related with the constructions and maintenance of the contour drains. Scarcity of the skilled labor during the season of planting and land preparation, usually it is overlapped with planting and land preparation because in order to start of the constructions it also needs some amount of moisture in the land (Figure 4.34). The incentives received for the constructions are not enough when compared with the amount what they spend for the constructions.

In loose soils like Bopitiya the contour drains are damaged by heavy rains due to the high run-off and another reason is damaged by strayed and wild animals.

4.3.6 A mind map of contour drains on the moderate slopes

Adoption of contour drains in moderate slopes is higher than on steep slopes because it is easier to construct in moderate slopes with deep soils. The adopters prefer the contour drains because it conserves the lands better and also keep more water in the land for long interval (Figure 4.35). They can endure the heavy rains and heavy run-off in the moderate slopes. Most tobacco farmers prefer the contour drains. The adopters mention that the investment is worthy in the long time.

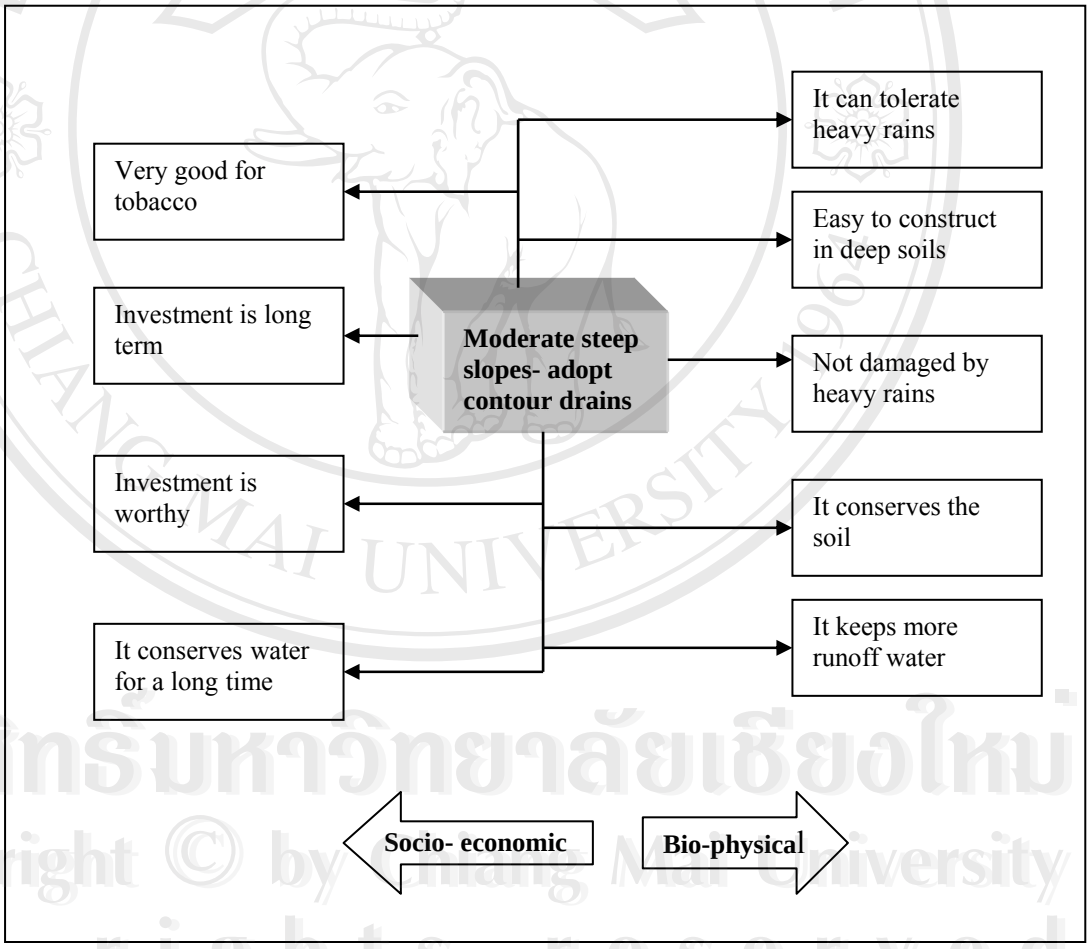

Figure 4.35 A mind map on reasons to adopt contour drains in moderate steep slope

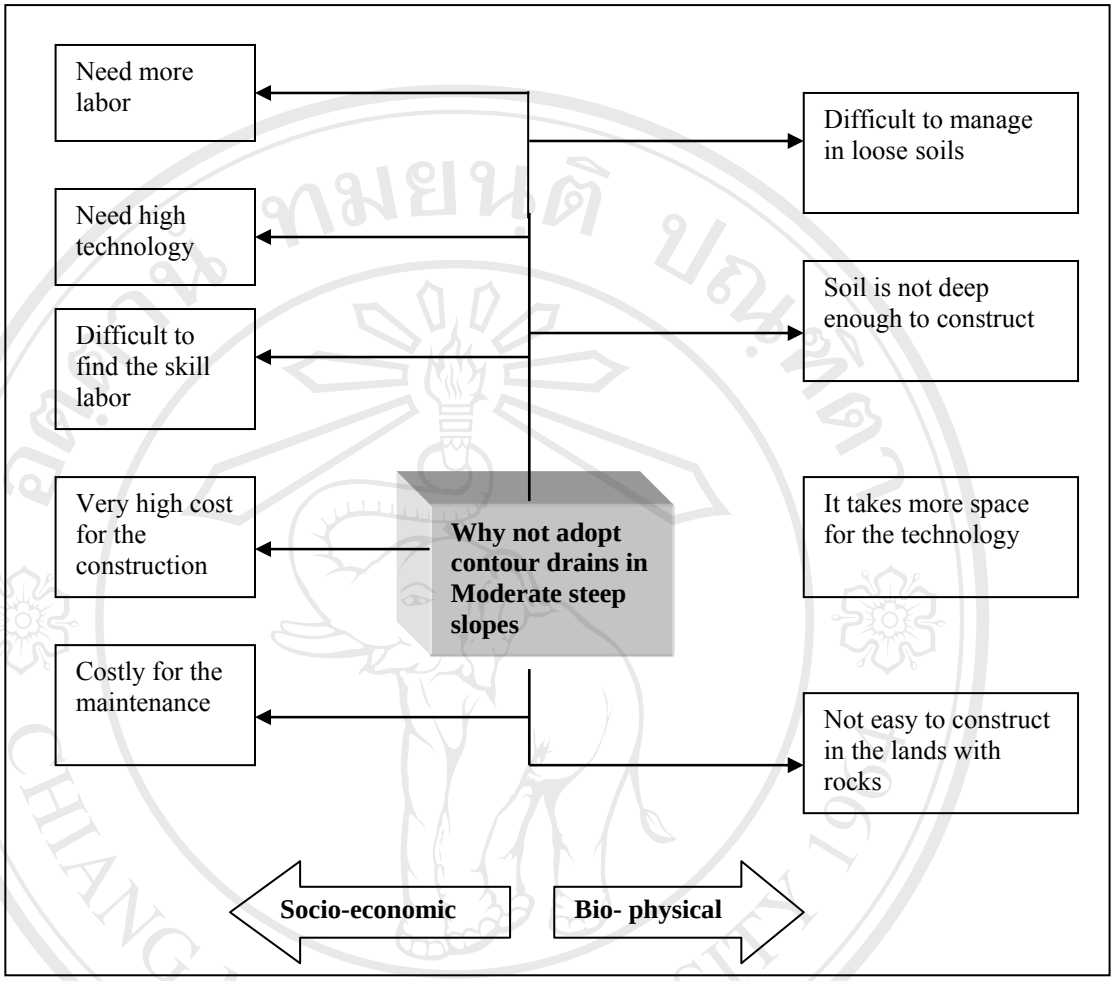

Figure 4.36 A mind map on reasons to not adopt contour drains in moderate steep lands

The non-adopters could not adopt because they lack of high skills and experience for constructions. Lack of the labor during the land preparation and the planting is another problem for them. The rocky land cannot be used to establish contour drains; the main thing is true with the lands where soils are not deep enough. Farmers also told that the technology takes more land space for the constructions and there had difficulties to manage contour drains in loose soils. The cost related to the constructions and the maintenance was another problem identified for the non-adoption of contour drains (Figure 4.36).

4.3.7 Benefits of conservation in adopters lands

The informal workshop generated very important information about the farmers who adopted soil conservation measures well in their lands. They mentioned about the rich soil cover with organic matter on topsoil. Other specific soil characters they could identify were moist and dark color soils. They observed that the soils which are fertile are rich with earthworms and other helpful organisms to keep the soil nourished. They could see the soils deposit just above the soil conservation structures. The crops established near the soil conservation structures gave very good yield and looks healthy (Figure 4.37). Another relief with healthy crop is fewer problems of pest and diseases. They realized well that the soil conservation structures save the soil as well as the soil moisture in the land. The amount of chemical fertilizer used was low that is a crucial factor for them to reduce the cost of production. They can grow high value crops in the lands to achieve a good farm income.

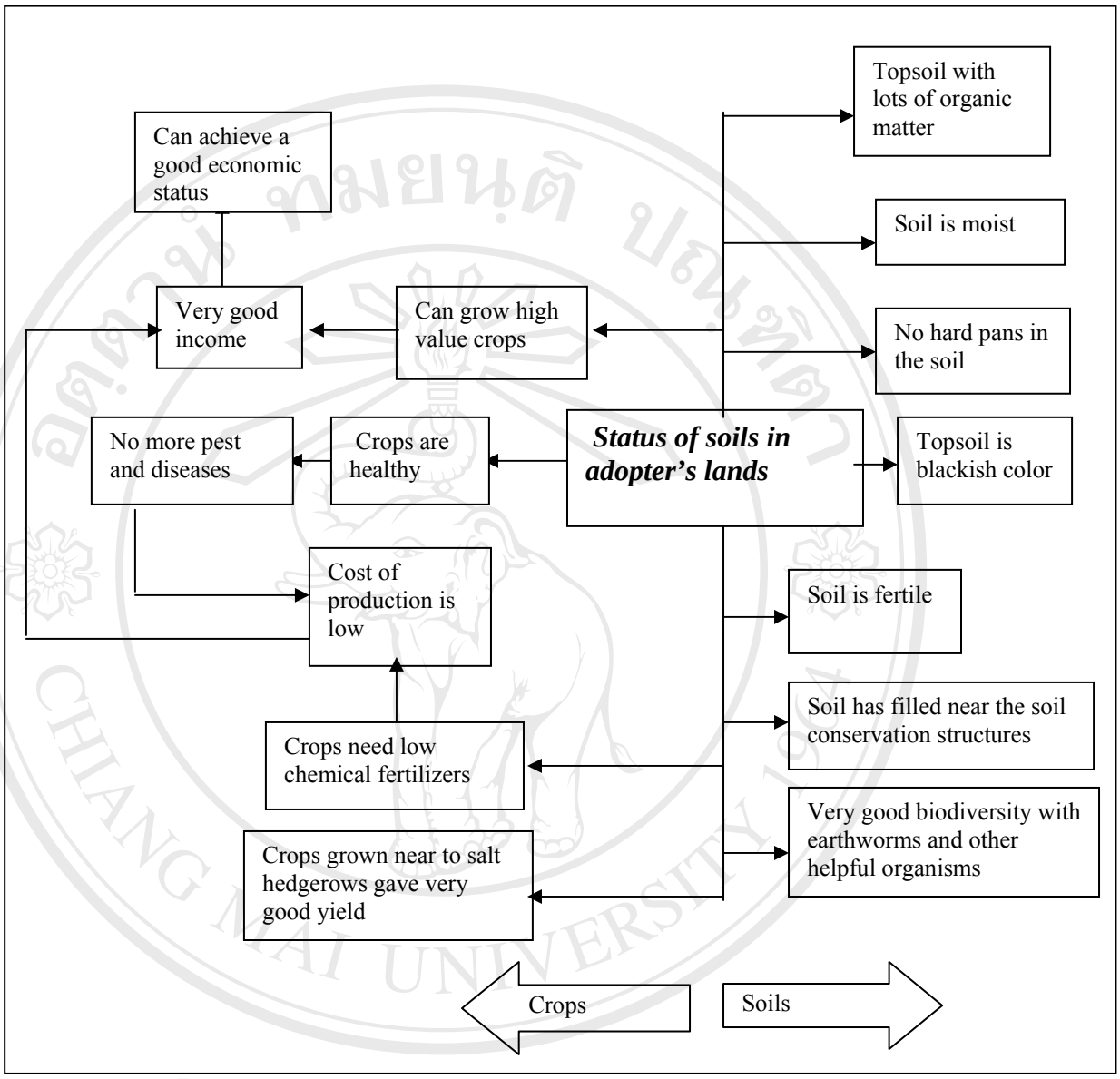

Figure 4.37 Benefits of soil conservation on adopter's lands

Due to soil erosion, the surface of the soil in non-adopters lands become harder and it become dry very soon. The bedrocks and gullies are easily observed on the soil surface. Soil fertility and biodiversity is very poor. Qualities of the crops they grow are very poor and they cannot achieve the good target of price and the income is lower from the lands (Figure 4.38). If they need to achieve good production, farmers have to invest more on the lands and they need higher amount of dosages of chemical fertilizers.

4.3.8 Effects of soil erosion in non-adopters lands

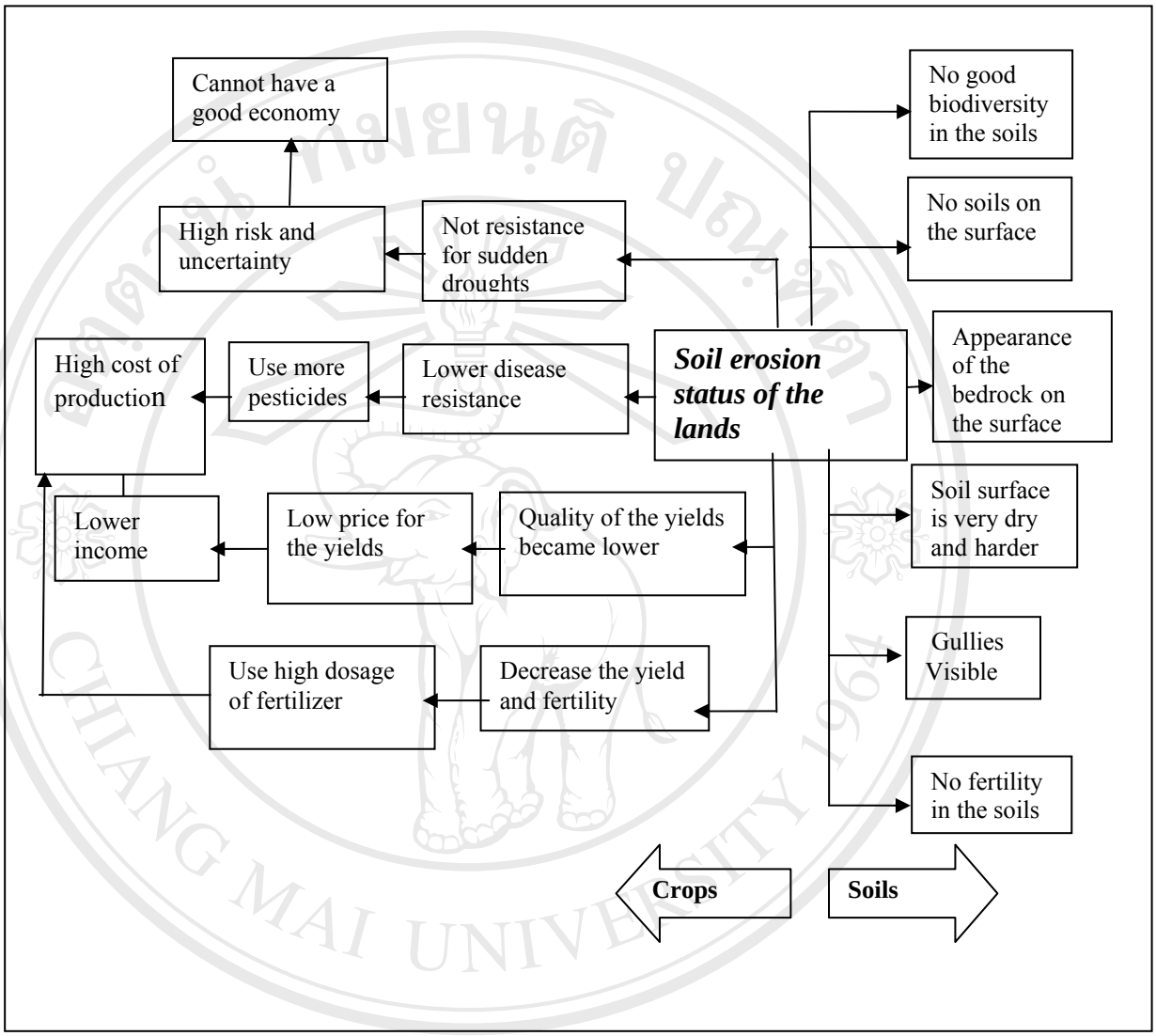

Figure 4.38 Effect of Soil Erosion in non-adopters lands

The crops grown in the lands are highly susceptible to pest and diseases and are not drought resistant. The agricultural production is too risky to promote as economical crops.

4.4 Factors affecting the adoption

4.4.1. Factors affecting the adoption of all conservation measures

The purpose of this analysis was to identify the land and farmer specific variables to determinant in implementation of soil conservation measures.

Socio-economic variables that were hypothesized to determine the adoption implementation of soil conservation practices include skills, own land, attitude and off-farm income. Erodibility1 was (not easily erodible soils) hypothesized as a biophysical factor to determine implementation of soil conservation practices.

Skills on conservation measures, own land area, attitude, and off-farm income was hypothesized to affect positively while erodibility1 was hypothesized to affect negatively.

The results of logistic regression analysis were presented in Table 4.1

Table 4.1 Factors affecting on adoption of conservation

Variable in the equation	β	S.E	Wald	df	Sig	Exp(β)
Skill	3.774	1.206	9.789	1	0.002	43.563
Own lands	0.866	0.435	3.960	1	0.047	2.378
Erodibility1	-1.198	0.553	4.695	1	0.030	0.302
Attitude	2.170	0.453	22.938	1	0.000	8.754
Off-farm	0.014	0.005	6.558	1	0.010	1.014
Constant	-5.316	1.371	15.039	1	0.000	0.005

Note: Exp (β) shows the predicted change in odds for a unit increase in the predictor.
Percentage correct prediction = 77.9 Omnibus Tests of Model Coefficients χ^2 =75.094, df =5, sig = 0.000 Cox& Snell R^2 = 0.396 ; Nagelkerke R^2 = 0.528

According to the results in Table 9 logit model for the conservation measures is

$$\left(\frac{p_i}{(1-p_i)}\right) = \text{Odds ratio} = 0.005 + 43.563\ \text{Skill} + 2.378\ \text{Own Land} + 0.302$$

$$\text{Erodibility1} + 8.754\ \text{Attitude} + 1.014\text{Off-farm} \text{----- (3)}$$

Where,

Skill	=	Dummy variable 0 indicates that the farmer has no skill for the establishment of soil conservation and 1 with skill for establishment of conservation measures.
Own Land	=	Land area by owned by the farmer (ha).
Erodibility1	=	Dummy variable, 1 for low erodible soil and 0 for otherwise.
Attitude	=	Dummy variable, 1 is for good attitude towards conservation measures and 0 for otherwise.
Off-farm	=	Off-farm income (Thousand Rs/yr).

In the present study, the overall goodness of-fit- measured by significant of χ^2 statistics is high. The percent of correct prediction is 77.9%. Cox & Snell and Nagelkerke R^2 show that independent variables can explain the dependent variables very well. The results also show that off-farm income, own land area, skill, and attitude contributes to the increase in the probability on adoption. But lower soil erodibility decreases the probability of adoption. Test of significance level of the variables indicates that skill, high erodibility of soil, attitude, off-farm income and constant are (1%) highly significant and own lands is significant at 5% level.

Holding other variables constant, the odds of applying soil conservation measures to specific fields are more than two times higher for those who have more owned land area. The results also indicate that holding other variables constant, the odds of using application of soil conservation in lands for those who have skill is increased by 43.5 times (Table 4.1). It also found that those who have the attitude

towards soil conservation application of soil conservation increase the odds by 8.7 times.

It was found that skill on establishment of conservation, area of owned land, availability of off-farm income and attitude towards soil conservation affect the odds-ratio of adoption positively. Those factors increase the probability of adoption. If farmers are not skilled on establishments, they cannot establish by themselves own, and they have to spend more money to hire skilled labor. But if farmer is skilled with these technologies it is no reason to hire skilled labor. Owned land area, and off farm income contribute to an increase in the probability of adoption. If farmers have more area of their own they have good security from their ownership right. Then they are willing to invest for construction of conservation measures. If they do not have the ownership right they are reluctant to adopt soil conservation technologies because they have to invest in other peoples land apart from what they have to spend for farming. Normally, when farmers start farming they have to spend on farm inputs. Without incentives or off-farm income it is very difficult for him to invest in soil conservation establishments. The results indicate that off-farm income increases probability of adopting soil conservation measures. Income from off-farm activities can be used to invest in soil conservation. The family that has more income from activities seems to have a higher potential for investing in soil conservation than the family that has less off-farm income. On the other hand, off-farm income can also have a negative effect on soil conservation adoption. A large amount of off-farm income means that family labor is more occupied with off-farm activities and less labor is available for establishment of soil conservation.

The research done in the highlands of Ethiopia to find out factors affecting on use of soil conservation (Regassa , 2002) suggested that the factors affecting for adoption were field ownership, labor, sex of household head, engagement in off-farm activities, livestock and field distance from home. According to her results ownership of the land, availability of family labor and male-headed household affected positively for the adoption. Involvement on livestock, and off-farm activities affected negatively for the odds ratio. In her research she mainly considers about the labor availability for

the soil conservation constructions. But in my research I have considered on investment on conservation, supporting the off-farm income.

Another research was done on land tenure and adoption of soil conservation practices by (Meridith *et al*, 2000). They found that total area of the farm, education, and improved drainage affected the adoption. For adoption of alley farming by farmers in the forest zone of southwest Cameroon (Akinwumi *et al*, 2000), it was found that family sizes, age, land right, village erosion index show the positive sign for the odds ratio. Likewise, research carried out for finding out the determinants of adoption of sustainable agriculture technologies on the hillsides of Honduras (Peter and Lee, 2003) suggested that the age, experience, education, irrigation, ownership, and slope of the lands were the determinants for the adoption.

According the results above farmers attitude and skill two personal factors, two resource endowment factors (own land area and off-farm income), and one physical factor (soil erodibility) had affected the odds-ratio of adoption of soil conservation.

4.4.2 Factors affecting adoption of SALT

Socio-economic variables that are hypothesized to affect the adoption of soil conservation practices include number of years stay in the village, and skill on establishments. Physical factor such as slope was hypothesized to affect odds-ratio of adoption of soil conservation practices.

When these variables were analized with logistic regression analysis the results are shown in Table 4.2.

Table 4.2 Factors affecting on adoption of SALT: (Sloping Agricultural Land Technology)

Variables in the Equation	β	S.E	Wald	df	Sig.	Exp(β)
Stay	0.152	0.047	10.204	1	.001	1.164
Skill	20.113	0.329	.0062	1	.003	15.002
Slope	-0.138	0.053	6.704	1	.010	0.871
Constant	20.958	1.635	0.499	1	.112	22.000

Note: Exp(β) shows the predicted change in odds for a unit increase in the predictor.
Percentage correct prediction = 88.00
Omnibus Tests of Model Coefficients, $\chi^2 = 36.705$; df = 3; Sig = 0.000
Cox& Snell $R^2 = 0.520$; Nagelkerke $R^2 = 0.693$

For SALT conservation measure, the resulting logit model according to the analysis of results in Table 4.2 can be expressed as:

Odds ratio = 22.000 + 1.164 Stay +15.002Skill +0.871 Slope ------- (4)

Where:

Stay = Number of year living in the village

Skill = Dummy variable to represent 0 for no skill in establishment of soil conservation and 1 for having skill in establishment conservation measures.

Slope = Average slope of the land in percent

In case of SALT conservation measure, the binary logistic regression results show high overall goodness of-fit measured by significant of χ^2 statistics (36.70). The percentage of correction prediction is high (88.0). The high R^2 of Cox& Snell (0.520) and Nagelkerke R^2 (0.693) indicate that independent variables can explain the dependent variable well.

Holding other variables constant, the odds of applying soil conservation measures to a specific land if farmers have skill on conservation the odds will increase by 15 times.

Using Exp(β) value (Table 10), if holding other variables constant the odds for the adoption of soil conservation for farmers who stay for long time in the village have 1.164 times of adoption that those who live short period in the village.

Significant negative coefficient for slope indicates that the steepness the slope of the land decreases the odds-ratio of adopting the SALT technology. The reason for this phenomenon is that when the land is too steep, recommendation for SALT for the higher slopes will make the spacing between two hedgerows narrower, and expenditure is high (See Appandix Table 2 and 4) . When the spacing in-between two SALT hedgerows become narrower less space are available for main crops and shading become a main problem for the crops. Farmer's skill has significant effect on the establishment of conservation measures. Significantly positive effect on probability of adoption is also shown by the length of stay in the village indicating that SALT conservation measure requires more attention to maintain.

4.4.3 Factors affecting adoption of stone terrace

Socio-economic variables that were hypothesized to affect the odd-ratio of adopting stone terraces include skill on establishments and attitude. The results of logistic regression analysis are shown in Table 4.3

Table 4.3 Factors affecting on adoption of Stone Terraces

Variable in the equation	β	S.E	Wald	df	Sig.	Exp(β)
Skill	0.027	0.092	2.000	1	.009	6.800
Attitude	3.127	0.914	11.695	1	.001	22.800
Constant	2.903	0.743	9.171	1	.203	9.500

Note: Exp(β) shows the predicted change in odds for a unit increase in the predictor.

Percentage correct prediction=85.7 Omnibus Test of Model Coefficient, χ^2 = 34.102; df = 2; Sig= 0.000

Cox of Snell R^2 = 0.501; Nagelkerke R^2 = 0.669

From Table 4.3 the odds-ratio for adopting terrace can be expressed as:

Odds ratio = 9.5 +6.8 Skill +22.8Attitude ------- (5)

Skill = A skill dummy variable, 1 if the farmer has ability to establish the conservation measures the value is 1, and 0 for otherwise.

Attitude = A dummy variable, 1 for good farmer's attitude towards soil conservation and otherwise 0.

In case of stone terracing, the overall goodness of-fit- measured by significant of χ^2 is higher (34.102). The percentage of correct prediction is (85.7%). Cox of Snell R^2 (0.501) and Nagelkerke R^2 (0.669) are also high indicating the independent variables chosen can explain the dependent variable well**.**

Holding other factors constant, application of soil conservation measures in a specific land those who having skill is increases the odds by 6.8 times while holding other factors constant, application of soil conservation measures in a person with positive attitude increases the odds by 22.8 times.

Result in table 4.3 shows that the most significant factor affecting the adoption of stone terraces is the attitude towards conservation measures. The attitude on soil conservation affects positively the log odds/ probability of adoption and it is in 1% of significance level. The skill on establishment of terraces significantly increases the log odds of adoption of stone terracing.

4.4.4. Factors affecting adoption contour drains

Socio-economic variables such as marketing facilities; attitude and off-farm income and soil erodibility were hypothesized to affect the odds-ratio for adopting the contour drains.

The results from the logistic regression on these variables are shown on Table 4.4.

Table 4.4 Factors affecting on adoption of contour drain soil conservation measure

Variables in the Equation	β	S.E	Wald	df	Sig.	Exp(β)
Marketing	1.902	0.961	3.916	1	.048	6.698
Erodibility1	-3.349	1.324	6.396	1	.011	28.475
Attitude	2.346	1.065	4.849	1	.028	10.443
Off- farm	0.032	0.012	6.657	1	.010	1.033
Constant	-7.109	2.219	10.265	1	.001	.001

Note: Exp(β) shows the predicted change in odds for a unit increase in the predictor.

Percentage correct prediction=82.00

Omnibus Test of Model Coefficient $\chi^2 = 30.109$; df = 4 ; Sig = 0.000

Cox of Snell $R^2 = 0.452$ Nagelkerke $R^2 = 0.603$

The above analysis can be expressed as the equation below

Odds ratio = 0.001 + 6.698 Market facilities28.475 Erodibility1 + 10.443 Attitude +1.003 Off-farm ----- -- (6)

Where

Market = Dummy variable, 1 is for good marketing facilities and 0 for otherwise.

Erodibility1 = Dummy variable, 1 for not erodible soil and 0 for otherwise.

Attitude = Dummy variable1, for good farmer's attitude towards soil conservation and otherwise 0.

Off-farm = Off-farm income (Thousand: Rs/year).

The contour drains has the overall goodness of-fit- measured by significant of χ^2 of 30.109. The percentage of correct prediction is higher 82.00%. Cox of Snell of R square is 0.452 and Nagelkerke R^2 is 0.603 indicating the independent variables chosen can explain the dependent variable well.

Holding the other variables constant, the odds of adopting contour drains to a specific field was about 7 times (Table 4.4) higher for those who have good access to marketing facilities. Holding other factors constant attitude can increase the probability of adoption by 10 times.

Availability of good marketing facilities, attitude towards conservation and availability of off farm income affect positively the probability of adoption. Especially when farmers depend on short-term farming, availability of marketing facilities plays a key role. That is the main reason for farmers who involve with tobacco are very difficult to withdraw from this crop, because they obtain fixed price and there is no marketing problem at all. If the economic status is good they are concerned much on conservation the land for better yields. If the erodibility of soils is low it will decrease the odd ratio of adoption the contour drains.

The farmers, attitude towards conservation significantly affects positively on the log odds for adoption. Farmers, decision to spend for establishments of the contour drain conservation measure mainly related to there economic status that in turn is governed by on-farm and off-farm income. In these results off-farm income contributes positively and it shows significant (1%) contribution for the probability of adoption. Marketing facilities, attitude and erodibility level contribute significant by at 5% level.

According to the above results one farmers' attribute (attitude), one physical character (soil erodibility status), one institutional (marketing) and one resource endowment factor (off-farm income) affect the odds-ratio for adoption of contour drains.