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Adoption Constraints for Soil Conservation Practices in Kyaukpadaung and Chaung U Townships, Dry Zone Region of Myanmar

(Shwe Mar Than[1] and Myo Sabai Aye[2])

[1] Deputy Director, ACARE, YAU, Myanmar
[2]Assistant Lecturer, Department of Agricultural Economics, YAU, Myanmar
*Corresponding Author: shwemar@gmail.com, dr.shwemarthan@yau.edu.mm

ABSTRACT-Soil degradation problems in central dry zone (CDZ) of Myanmar are getting worse. If no proper soil conservation practices are practiced and enough measures are taken out the farmers have to leave their land. The problems are to be solved urgently and the farmers are very much in need for help. Vast majority of farmers in central dry zone of Myanmar are facing land degradation related poor productivity problems. Major causes of soil degradation are water erosion in the slops, continuous mono-cropping patterns for long term, converting Yar land into low land by pump irrigation projects, use of underground water for long time, and wind erosion in the study area. Furthermore, the salinization and/or alkalinization problems occur because of scarce rain and high evaporation. The study aims to understanding the constraints for adoption of soil conservation practices in the study area and to find out the constraints for adoption of soil conservation management.

65 respondents from Kain were, Kyauk Tagar, Medee and Kataw villages were selected in Kyaukpadaung Townhsip and 40 respondents from Taw Kyaung Gyi, Than Pin Kan, New Khway and Khin Mon village were selected in Chaung U Township for the study. About 29 percent of land were observed as degradated land. Water erosion shared 49 percent of total land degradation and which is followed by 18.3 percent of manmade problems or malpractices in farming, 15.1 percent of wind erosion, and 14 percent of salinity problem because of high temperature and scare rain. Among soil conservation practices, contouring and construction of stone wall were the most costly practices but the cost can be spread over several years that if is worth investing. Crop loss due to land degradation were estimated and it is assumed as the benefit of soil conservation, which means if the soil conservation practices are adopted the farmer will achieve the average yield from their farm. Amount of crop loss per acre ranges from 44-67 % in Kyaukpadaung Township and 29-70 % in Chaung U Township. The most binding constraints for adoption of soil conservation practices was not enough capital (65%) and followed by technological limitation problem by 16%. Therefore, the government should consider the aid or subsidy program for soil conservation and should strengthen knowledge extension program on soil conservation.

Key Words: *soil conservation, water erosion, wind erosion, salinity problem, malpractices in farming, capital and technological limitation*

INTRODUCTION

If current rates of land degradation continue all of the world's top soil would be gone within 60 years and generating three centimeters of top soil will take 1,000 years, a senior UN official said on December 5, 2014 according to the Reuters News. Soil degradation problems in central dry zone (CDZ) of Myanmar are getting worse. If no proper soil conservation practices are practiced and enough measures are taken out the farmers have to leave their land. The problems are to be solved urgently and the farmers are very much in need to be helped. Vast majority of farmers in central dry zone of Myanmar are facing land degradation related poor productivity problems.

Top soils are being removed by wind and water because the soil type in CDZ is mostly sandy. The prominent soil type in the dry zone area is sandy or sandy loam and soil fertility is depleted because of wind and water erosion. If the land has some degree of slope it worsens the problem. Furthermore, the salinization and/or alkalinization problems occur because of scarce rain, high temperature and high evaporation. This phenomenon is also unavoidable because we are living now in global warming scenario. The amount of evaporated water is much more than the amount of rain water that the salinization problems emerge. Whereas many soil problems are occurred naturally, there are some man-made soil problems in CDZ as well.

There are two types of land in the central dry zone: upland (Yar Myae) and low land (Le Myae). The land degradation problems are observed in both types of land. The cropping pattern in Kyak Mauk Taung Dam irrigated area in Kyaukpadaung Township (Rice-Rice pattern). Farmers grow rice in the monsoon and after harvesting monsoon rice they grow summer rice. They do not practice any crop rotation and continuously grow rice for many years and soil are under the submerge condition for most of the time that the soil structure is heavily destroyed. The problem is so severe that only manual labor is possible to till the land.

Another soil problem in Chaung U Township occurred when farmers change their land from upland to lowland to grow rice. There was electric water pumping project from Chindwin River in the area more than 10 years ago. However, the irrigation canals are not concrete canals and the fields are irrigated by the earth canals. In upland of the central dry zone, the soils are originally more or less alkaline. When the land was changed from up land to low land, the salts melt down in the water and

moved along the irrigation water. The salts accumulated in some fields and make the fields alkalization problem. The affected areas of land become larger from year to year.

The other soil problem in Chanung U Township was occurred by irrigating the land with underground water. It is in Khin Mon village and there is no extra source of water except from underground water so that they grow crops by pumping water from underground. The quality of water is never tested and many areas of land became harden and some lands have been left uncultivated for several years. The problem has to be named technically.

There are several soil conservation practices recommended by the land use division of Department of Agriculture (DOA) and the department of agricultural research (DAR). They are zero tillage or minimum tillage to conserve the soil, crop rotation, growing cover crop, crop residue management, water conservation, contour farming, systematic utilization of chemicals and inorganic fertilizers and other agro chemicals, and improved nutrient cycling and so on. Some farmer practice zero tillage for the second crop if it is chickpea. Otherwise, no zero tillage is practiced. In this case, they practice zero tillage not for soil conservation but for to rush for next crop and to catch the soil moisture. There are many advantages of practicing zero tillage. The farmer can save machine or animal power to till the soil at least.

No-till is a conservation practice that leaves the crop residue undisturbed from harvest through planting except for narrow strips that cause minimal soil disturbance. Crop residues are materials left in the field after the crop has been harvested. These residues include stalks and stubble (stems), leaves and seed pods. Good management of field residues can increase efficiency of irrigation and control of erosion. No-till can be used for almost any crop in almost any soil and can save producers labor and energy cost. It's a sound investment for the environment and the farm. The soil conservation practices such as zero tillage, crop rotation, and residue management with no or low cost. Natural vegetation along the contour line does not add extra cost to farmers but it conserves the soil as well. But they just need to be made aware by the farmers. Aside from those, other practices such as making contour bund, growing wind breaks, and water conservation need some amount of investment. The common treatment for acidic soil is to add lime to the field and for alkaline soil is to add gypsum to the field. Applying animal manure and crop residues improve the soil structure better and add some level of organic matter to the soil. Above mentioned practices were asked to the farmers by structured questionnaire.

The Dry Zone covers approximately 8,718,898 Hectare (13 percent of the country's total land area) and is situated in Magway, Mandalay and the lower Sagaing Division. CDZ was identified by based on mean annual precipitation rates and which covers 13 districts and 57 townships. The current population of the Dry Zone is roughly 11.5 million, some 27 percent of the country's total population. Annual precipitation in the Dry Zone is on average less than 30 inches (750 mm). Temperature ranges from a minimum of 12 C to a maximum of 44 C during the warmest period of the year (March-April).

The Dry Zone soil types are characterized by clay, sandy loam and sandy soils (including gravel). The soils clearly vary with topography. According to soil survey data, all soil series have low fertility and declining amount of organic matter levels. Potassium levels are considerably low. Nitrogen is required for all non-legume crops on all soil types. This suggests the low organic matter level in the soil. Available soil moisture holding capacity of the soils of the Dry Zone is low and with the high level of evapotranspiration, constitutes a major constraint to crop growth during periods of inadequate rainfall (June and July). Management practices that conserve soil moisture or increase the water holding capacity of the soils are being practiced to help take advantage of the full growing season.

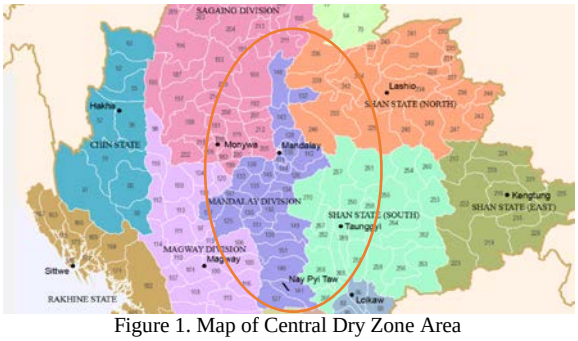

Figure 1. Map of Central Dry Zone Area
(Mandalay, Magway and Lower Sagaing Division)

Soil erosion is a serious problem and the soil has almost completely removed by water and wind erosion in some places. Soil erosion is particularly severe in the upland areas of Kyaukpadaung and Chaung U largely as a result of the high intensity of rainfall and surface runoff in slopes, ranging from 5-15%. The erodibility of the soil in slopes is relatively very high. In Chaung U the most severe erosion occurs in the upland areas. Hard pan formation is common to all upland areas. But the soil erosion in Kyaukpadaung township can be observed both in low land and upland.

1.2 Objectives of the Research

General Objective

The research generally aims to understanding the constraints for adoption of soil conservation practices in the study area.

Specific Objectives

The study specifically aims –

1) To measure the degree of land degradation problems at farmer's level.
2) To explore the extent of soil conservation practices currently being practiced by the farmers,
3) To identify the constraints for decision making of soil conservation practices adoption,
4) To know the level of investment they did for the soil conservation and
5) To compute the costs and benefits for different soil conservation methods for policy recommendation.

2. Study Area

2.1 Kyaukpadaung Township

Kyaukpadaung Township is 1954.2 km^2 wide and population residing there were 261,908 as of March, 2014. Of which 83.7 percent resides in rural area. Kyaukpadaung Township is the southwestern most township in Myingyan District and bordering with Taungtha, Mahlaing, Meiktila, Natmauk, Yenangyaung, Chauk, and Nyaung-U Township. Rural population relies more on agriculture and cropping systems are such as mix cropping, intercropping, and relay cropping. Oil seed crops such as sesame and peanut are grown as a mono crop occupying vast majority of cropping area. Rice is grown where the places with access to irrigation water. The study sites were in Kyauk Tagar, Medee, Kadaw and Kaing village. The villages were selected based on the severity of land degradation problem. Those villages have significant land degradation problems than any other areas in the township.

Figure 2. Map of Kyaukpadaung Township showing study sites

2.2 Chaung U Township

Chaung-U is located in Monywa District, Sagaing Division. It is situated in 231.46 feet (70.55 m) above sea level at north latitude 22° 45' and east longitude 95° 8' to 95° 25'. It is 493.63 km^2 wide and population size in 2014 was 105,955. Of which 79.3 percent dwell in the rural area. The Monywa–Mandalay highway road passes it, so the communication is good, quick and easy. Neighboring townships are: Myinmu, Myaung, Salingyi, and Monywa. The Chindwin River is in the west of the township and which is six miles away from the town. Since there are much farmlands all over the township and rice, pulses, wheat, maize, sesame, niger, sunflower, chili, onion, garlic, cotton, and some minor crops were grown.

The unique soil degradation problem in Chaung U township arises from excessive utilization of underground water for long time. Khin Mon village is well-known for that problem. And there is Chindwin river pumping project to convert land from upland (Yar land) to lowland (Le land) in order to expand rice growing area. Water is pumped from the river and irrigated to the fields by using earth cannels. Gradually, some of the fields are facing cumulative problem of soil. The white layer of salt was observed and many rice hills went died during their vegetative stage.

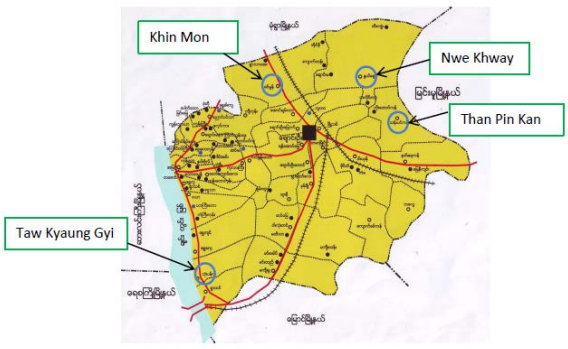

Figure 3. Map of Chaung U Township showing study sites

3. Research Methodology

3.1 Research Questions

The study asked the following research questions:

1) What soil conservation practices are being adopted by the farmers and what is extent of adoption?
2) What are the most binding constraints for adoption of potentially successful approaches, and to improve the options for conserving the land?
3) What are the sources of knowledge on these conservation practices and what investments are needed by the farmers to adopt these conservation practices?
4) What supports would they need to adopt or increase coverage of the practice?

3.2 Conceptual Framework

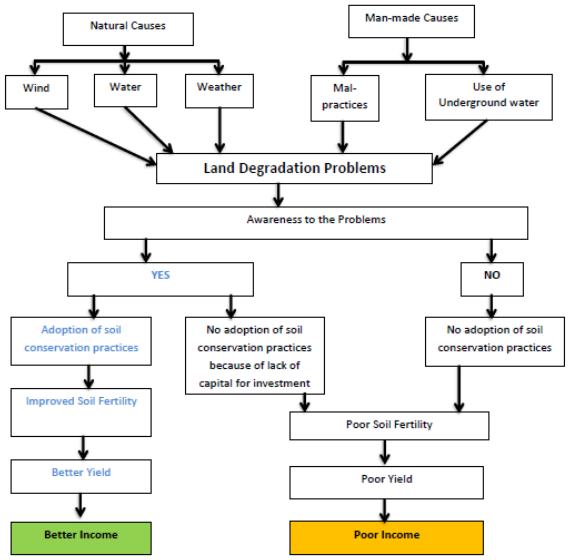

Figure 4. Conceptual Framework

3.3 Measured Variables

The demographic characters of the respondent farmers, the detail land ownership and the history of the soil problems were collected. All kinds of crops grown on their land, crop yields, prices, and non-farm source of income were obtained. The nutrient status of the soil in general, the adopted soil conservation practices, involvement of men and women in decision making for adopting the soil conservation practices, the adopted duration, the source of information obtained, the constraints for adoption were collected. Furthermore, the constraints for soil conservation practices were asked to the respondents.

3.4 Data Collection Method

The survey used both primary and secondary data. The study areas were selected from the central dry zone of Myanmar where the soil erosion problems are significant. Among the problem soil areas, Kyaukpadaung and Chaung U townships were chosen because they have different problems of soil such as nature-made soil problems and man-made soil problems.

Pilot survey was conducted in Kyaukpadaung Township from March 1 to 2, 2015. Main survey was conducted in both Townships from April 7 to 10, 2015. All possible soil conservation 2practices based on literature review were included in the questionnaire and screened based on the information which were gathered during pilot survey. Then the sample farmers were asked by conducting one on one interview. Purposive random sampling method was used for choosing the sample. The list of farmers who has soil problem was obtained from the respective township office of Department of Agriculture (DOA) and then sample size was determined. In Kyaukpadaung Township, there are 299 farmers who are facing soil problems and the area of problem soil was 243.2 acres. In Chaung U Township there are 140 soil problem facing farmers owning 386 acres were reported by the respective DOA offices. Therefore, 65 respondents from Kyaukpadaung Township and 40 from Chaung U Township, totally 105 respondents were interviewed by using pre-tested questionnaires. The required secondary data were obtained from the respective Township offices of the Department of Agriculture (DOA).

4. Results and Discussions

4.1 Demographic Facts about the Respondents

Average age of household heads varied from 32 to 81 years in Kyaukpadaung (KPG) township, and from 27 to 76 years in Chaung U (CHU) township. Average age of household heads was about 51 years old for both townships. Average education level of sample farmers in KPG was 7 years and in CHU was 6 years. For all sample farmers, the education level was only middle school education. Average farming experience was 27 years for both townships. Average number of family labors and number of dependents were 3 and 2 for all townships (Table 4.1). All of the demographic facts are not significantly different for both townships.

Table 4.1. Demographic characteristics of respondents in Kyaukpadaung and Chaung U Townships.

Item	Kyaukpadaug (N=65)			(Chaung U (N=40)			All Respondents (N=105)		
	Min	Max	Aver	Min	Max	Aver	Min	Max	Aver
HHH Age	32	81	51	27	76	52	27	81	51 (0.4560)^{ns}
Education	4	11	7	2	14	6	2	14	7 (0.4062)^{ns}
Farming Experience	4	50	27	2	57	27	2	57	27 (0.7989)^{ns}
No. Flab	1	6	3	1	8	3	1	8	3 (0.1837)^{ns}
No. of dependent	0	8	2	0	8	2	0	8	2 (0.6847)^{ns}

Note: Numbers in parenthesis are probability value for t-statistics. ns = not significant

Note: Numbers in parenthesis are probability value for t-statistics. ns = not significant

4.2 Land Information

Table 4.2 presents the information about land ownership and problem soil information of sample respondents. Average own land size of sample farmers in KPG was 8.5 acres, in CHU was 16.3 acres and for all sample farmers was 11.4 acres, which was found to be statistically significant. Average number of plots was 6.1 for all sample farmers. The average share of problem soil is 29.2 percent of their total land holding. Similarly, 41.7 percent of their land plots were having soil problems which resulted in poor productivity. It was not a small and negligible portion of their own land. Almost half of their land was in problem which resulted in poor productivity and poor income.

Table 4.2. Land information of respondents in Kyaukpadaung and Chaung U Township.

	Kyaukpadaug (N=65)			Chaung U (N=40)			All Respondents (N=105)		
	Min	Max	Average	Min	Max	Average	Min	Max	Average
Own land area (Acre)	1	32.5	8.5	1	50	16.3	1	50	11.4 (0.0001)***
Rented Land area (Acre)	0	9.5	0.9	0	2	0.1	0	9.5	0.7 (0.0700)
Total land area (Acre)	1	32.5	9.7	1.5	50	16.1	1	50	12.2 (0.0016)***
Total no. of plots	1	15	6.6	1	21	5.3	1	21	6.1 (0.1039)^{ns}
Area of land in problem	0.2	11.5	2.1	0.5	20	5.4	0.2	20	3.3 (0.0001)***
No. of plots in problem	1	10	2.2	1	6	1.8	1	10	2.1 (0.2269)^{ns}
Percent of problem land (%)	1.8	100	26.6	4.5	100	33.3	1.8	100	29.2 (0.1309)^{ns}
Percent of problem plot (%)	7.1	100	37.2	11.1	100	41.7	11.1	100	41.7 (0.3811)^{ns}

Numbers in parenthesis are probability value for t-statistics. ns = not significant and *** means highly significant at 1% significant level.

4.3 Reasons for Land Degradation

There are several reasons for land degradation. The study, however, has chosen six types of land degradation based on pilot survey and local information. They were water erosion, wind erosion, continuous monocropping, drought and extreme temperature, continuous practice of same cropping pattern for a long time, and other problems. The unique soil problem in Kyaukpadaung township is the damage of soil structure because of practicing rice-rice cropping pattern for a long time. The many areas of land in Kyaukpadaug township has a slope that it becomes causal factor for water erosion. Majority farmers in KPG township cultivate land long before the growing season. They practice repeated tillage cultivation that soil becomes fine particles which were easily flown away as the wind blows. For this reason, their soil becomes more and more sandy than before but the

farmers do not notice this practice as the reason of soil degradation.

The unique problem in Chaung U township is because of pump irrigation from the river and from underground water. Although the Chindwin River is one of the four major rivers in Myanmar and the quality of water itself is good enough to use as irrigation water, the quality of underground water was never tested. There has been an agricultural policy for converting upland area to become lowland area to expand rice growing area since 1988 or the time of State Law and Order Restoration Council (SLORC). The government encouraged to convert many areas of land to become rice land that there was an electric river water pumping project in Chaung U Township. The government supported with pumping facilities there, but it did not provide the concrete irrigation canal. That is why farmers have to use earth canal to irrigate the river water into their fields. Chaung U is one of the Townships in central dry zone area of Myanmar and the soil pH is relatively higher than the lower part of Myanmar. The metal ions are cumulated in top soil layer because they come along with evaporation from soil. When the water was irrigated along the earth canal they dissolved in the water and flowed into the rice field. The salts were accumulated in the field gradually and finally the land was destroyed. The other man-made problem in Chaung U Township was because of using underground water for agriculture. The underground water irrigated area became very hard in texture and it looks like a hard pan that the land is not possible for cultivation anymore.

Table 4.3 presented the case of land degradation in the study areas. Man-made factor or mal-practice in cultivation was the biggest causal factor in Kyaukpadaung Township which shared 31.3 percent of total problem soil area. Then, it was followed by the weather phenomenon of extreme temperature and scarce rainfall degraded the land by 30.3 percent. The third most causal factor for land degradation was water erosion since many area of the land has slope. If continuous monocropping system and practicing of single cropping pattern together resulted 11.8 percent of causal factors for land degradation in Kyaukpadaung Township. They practiced monocropping system for a long time. Respondent farmers notice the problem in their soil for about three or four decades and claimed that they noticed the problem become serious during last decade.

In Chaung U Township, water erosion was the most frequently observed factor for soil erosion with 63.33 percent of total problem soil, which was followed by wind erosion with 19.81 percent and man-made erosion of irrigation water problem stood at third place with 11.52 percent. Respondents claimed 5.34 percent of their problem soil was because of high temperature.

For all respondents in both townships, water erosion was the most serious problem with 48.7 percent and followed by man-made problems (18.3 percent), wind erosion (15.1 percent), high temperature (13.9 percent) and continuous monocropping (4.2 percent).

Table 4.3. The causes of land degradation in Kyaukpa-daung and Chaung U Township

		Kyaukpadaug (N=60)		Chaung U (N=45)		All Respondents (N=105)	
		Total Area of problem soil (Ac)	% of total problem soil	Total Area of problem soil (Ac)	% of total problem soil	Total Area of problem soil (Ac)	% of total problem soil
1	Drought and high temperature (N=20)	70.5	30.3	24.0	5.3	94.5	13.9
2	Water erosion area (N=35)	47.8	20.5	284.5	63.3	332.3	48.7
3	Wind Erosion area (N=11)	14.3	6.1	89.0	19.9	103.3	15.1
4	Continuous monocropping (N=5)	21.0	9.0	0.0	0.0	21.0	3.1
5	Continuous single cropping pattern (N=3)	6.5	2.8	0.0	0.0	6.5	1.0
6	Other problems (N=54)	73.0	31.3	51.8	11.5	124.7	18.3
	Area of Total problem soil	233.0	100	383.3	100	682.2	100

Note: (N) = Number of samples.

4.4 Severity of Soil Erosion Problems

Severity of soil erosion problems varies from farmer to farmer and from place to place. The severity was measured by given the score from 1 to 5. If the problem is very severe and it hurts the farm family economically the score of 5 was given. Then, the score 4 for severe, 3 for noticeable stage, 2 for a little bit of problem, and 1 for no problem in the particular type of soil erosion. The collected information regarding the severity of soil erosion severity was organized in Table 4.4. According to the claims of the respondents practicing the drought and high temperature was the most frequent causal factor for the soil degradation and claimed by 77 respondents and followed by the continuous monocropping system (50 respondents), water erosion (47 respondents), wind erosion (40 respondents), continuous single cropping pattern (32 respondents), other problems (29 respondents).

The severity of soil problem caused by drought and high temperature was claimed to be very sever by 27 respondents from both townships, where 20 from Kyaukpadaung Township (KPG) and 7 from Chaung U Township (CHU). 18 respondents from KPG claimed the high temperature was very severe cause to soil erosion and 11 from CHU claimed so. Continuous mono-cropping was claimed to be the second most causal factor for soil erosion. 7 respondents claimed that it was very severe in KPG and same number of respondents said it was the same as in KPG. Water erosion and wind erosion were the third and fourth most causal factors for soil erosion. Severity of water erosion was claimed by 31.9 percent of respondents from both township to be very severe and 34 percent of respondents said it was severe. 12 respondents from KPG and 19 respondents from CHU claimed it was more than noticeable. Wind erosion was claimed to be very severe by 22.9 percent of respondents from both townships and severe by 30 percent of respondents from both townships. 10 respondents from KPG claimed the wind erosion was more than noticeable and 11 respondents from CHU said the same as in KPG. Continuous single cropping pattern was the fifth most causal factor for soil erosion. 25 percent of respondents claimed to be very severe and 21.9 percent was claimed to be severe in both townships. The other problems such as irrigation water management problems was claimed by

severe by 13 farmers in KPG and 11 farmers in CHU. Severity degree were by the perception of farmers only. If they feel the causal factor was the worst in their condition they scored it 5.

Table 4.5 presented the adoption of soil conservation practices by the respondents. It was found

Table 4.4. The severity of soil erosion problem in Kyaukpadaung and Chaung U Townships

No.	Name of Soil Problem	Very Severe	Severe	Noticeable	A little	No problem	No. of problem answers
		5	4	3	2	1	
1	Drought and high temperature	27 (35.1)	29 (37.7)	13 (16.9)	8 (10.3)	5	77 (100)
1.1	Kyaukpadaung	20	18	10	4	0	52
1.2	Chaung U	7	11	3	4	5	25
2	Water erosion	15 (31.9)	16 (34.0)	8 (17.0)	8 (17.0)	58	47 (100)
2.1	Kyaukpadaung	7	5	5	6	42	23
2.2	Chaung U	8	11	3	2	16	24
3	Wind Erosion	9 (22.5)	12 (30)	11 (27.5)	8 (20.0)	65	40 (100)
3.1	Kyaukpadaung	6	4	7	5	16	22
3.2	Chaung U	3	8	4	3	49	18
4	Continuous mono-cropping	7 (14)	7 (14)	10 (20)	26 (52)	72	50 (100)
4.1	Kyaukpadaung	5	2	7	14	32	28
4.2	Chaung U	2	5	3	12	40	22
5	Continuous single cropping pattern	8 (25.0)	7 (21.9)	7 (21.9)	10 (31.3)	73	32 (100)
5.1	Kyaukpadaung	7	4	3	8	11	22
5.2	Chaung U	1	3	4	2	62	10
6	Other problems	16 (55.2)	11 (37.9)	2 (6.9)	0 (0)	76	29 (100)
6.1	Kyaukpadaung	11	2	1	0	10	14
6.2	Chaung U	5	9	1	0	66	15

Note: The numbers in parenthesis are percentage.

4.5 Adoption of soil conservation practice

Among six reasons for the soil degradation, the first three reasons presented in the Table 4.4 such as drought, water erosion and wind erosion are natural factors and there is no particular conservation practice for extreme weather such as drought. However, for the water and wind erosion, the soil can be conserved by building of stone walls, making contour bunds, growing the wind breaks, and growing natural vegetation along the contours. Minimum tillage is a conservation method for wind erosion. The other three causal factors were man-made factors for soil degradation. The respondents in the study area do not change crop or cropping pattern for a long time. Many farmers in Kyaukpadaung Township grow rice-rice cropping pattern for about 4 decades. This problem can be solved by changing crops and cropping pattern, applying residue back to the field, applying recommended amount of organic manure to the field, applying lime or gypsum to the field based on the severity of soil problem, and including pulses in the cropping system. Furthermore, the managed irrigation is also one of the conservation methods.

that majority of farmers do not know the proper conservation method for their soil problem. The method they most practice is applying farmyard manure (FYM) and gypsum to the field. Only 8.2 percent and 7.4 percent of respondents who have water erosion problem fully practiced the contour bund and stone wall construction. 14.4 percent and 11.6 percent of them partially practiced contouring and stone wall construction as soil conservation practices. Around 25 percent of respondents know the soil conservation method but they did not practice. And, more than 50 percent of respondents did not know they should practice contour farming or stone wall construction for soil conservation. 32.2 percent of the respondents did not know that they should grow wind breaks to prevent wind erosion. 25 percent of respondents know that they should grow wind breaks but they didn't.

68.4 percent of respondents did not know the minimum tillage cultural practice as a soil conservation method and 22.1 percent of them know the method but they did not practice. 37.5 percent of respondents did not know the leaving the fallow land as a soil conservation practice and 30.2 percent of them knew it but they did not practice. Similarly, 52.2 percent of respondents did not know the

managed irrigation as a soil conservation method and 23.3 percent of them knew it but they did not practice. Growing natural vegetation along the contour bunds was fully practiced by 25.6 percent of respondents, 24.4 percent of them practiced partially, and 36.5 percent of them did not know it as a soil conservation practice. The soil conservation practice the farmers do most is application of farmyard manure or composts or gypsum to their fields to improve the soil texture and soil pH and 60.3 percent of farmers fully practice and 30.8 percent of them practice it partially as a soil conservation method. One third of respondents did the residue management properly, but another one third did not practice although they know the technology. Intercropping with pulses was fully practiced by 23 percent and partially practiced by 30.6 percent.

with pulses, managed irrigation, natural vegetation, applying FYM or Gypsum, fallowing and cultivation soil with minimum tillage. The cost of soil erosion practices per acre in Kyaukpadaung and Chaung U Townships were presented in Table 4.6.

The values were average costs for each practice and the numbers of farmers who practice particular soil conservation practice were shown in the parenthesis. The costs were decomposed into labor cost, machinery cost and material cost. Labor cost was classified into family labor, and hired labor. Based on computation in Table 4.6, building of stone wall was found to be the most expensive practice and average cost of which was 312,714 Ks. per acre that only 7 respondents could practice among all 105 respondents. Which was followed by making contour bunds (average cost per acre was Ks. 91,909) and applying

Table 4.5. Numbers of adopters for soil conservation practices

	Soil Conservation Practices	Fully Practiced	Partially Practiced	Know it but not practice	Do not know the practice	Total
1	Contouring	8	14	25	50	97
		(8.2)	(14.4)	(25.8)	(51.5)	(100)
2	Construction of stone wall	7	11	25	52	95
		(7.4)	(11.6)	(26.3)	(54.7)	(100)
3	Growing wind breaks	16	25	24	31	96
		(16.7)	(26.0)	(25.0)	(32.3)	(100)
4	Minimum tillage	7	2	21	65	95
		(7.4)	(2.1)	(22.1)	(68.4)	(100)
5	Leave fallow	9	22	29	36	96
		(9.4)	(22.9)	(30.2)	(37.5)	(100)
6	Managed irrigation	7	15	21	47	90
		(7.8)	(16.7)	(23.3)	(52.2)	(100)
7	Natural vegetation	23	22	12	33	90
		(25.6)	(24.4)	(13.3)	(36.7)	(100)
8	Apply residue back	30	18	31	21	100
		(30.0)	(18.0)	(31.0)	(21.0)	(100)
9	Intercropping with pulses	22	30	27	19	98
		(22.4)	(30.6)	(27.6)	(19.4)	(100)
10	Applying FYM or Gypsum	47	24	1	6	78
		(60.3)	(30.8)	(1.3)	(7.7)	(100)

The numbers in parenthesis are percentage.

According to the results extension education for the farmers is found to be extremely in need. Many of them are practicing wrong method for treating their soil. The land resource is scarce and expensive they would like to develop their land but they just don't know how. Many of them know it from somewhere else, but they do not have enough capital to adopt the conservation method. Investment in soil conservation is a long-term investment that the farmers' interest and willingness are very important to conserve their land.

4.6 Costs of Soil Conservation Practices

Average sample farmer fully practiced 1.7 soil conservation methods and partially practiced 1.7 soil conservation methods. Totally there are ten methods of soil conservation methods considered in the study and they are contouring, construction of stone wall, growing wind breaks, apply residue back to the field, intercropping

FYM and gypsum (average cost per acre was Ks. 81,581) which was practiced most among all respondent farmers. Seventy nine respondents out of 105 were practiced this method for soil conservation because apply farmyard manure to the land is traditional way of soil conservation. Although many of farmers could not follow the recommended rate of FYM and gypsum, it was found that majority of farmers practice this as a traditional way of soil conservation method.

Applying crop residues back to the field also helps the land to enrich the organic matters. Only 5 respondents claimed that they put back the crop residues to their fields and many of them need crop residues to use as animal feed. Rice straw and pulses plant parts are being used as animal fodder in Myanmar that it has opportunity costs to practice this method as a soil conservation method. Availability of animal feed is very limited especially in the dry zone region. Managed irrigation practice and growing windbreaks were practiced by 6 respondents each as soil conservation practice. Managed

irrigation costed Ks. 29,750 per acre and growing wind breaks costed Ks. 27,400 per acre. Growing vegetation along the contour line was practiced by 10 respondents and it costed Ks. 24,950 per acre.

Table 4.6. The cost of soil conservation practices per acre in Kyaukpadaung and Chaung U

		Family labor cost	Hired labor cost	Total Labor Cost	Machine/ animal-power cost	Material cost	Total Non-labor	Total Conservation Cost
		(1)	(2)	(3)=1+2	(4)	(5)	(6)=4+5	(7)=3+6
1 (N=11)	Min	0	0	2,500		0	0	6,000
	Max	120,000	180,000	216,000		220,000	320,000	536,000
	Aver	14,864	30,364	50,318		26,727	41,591	91,909
2 (N=7)	Min	0	0	4,000		18,000	46,000	74,000
	Max	28,000	210,000	213,000		320,000	533,000	746,000
	Aver	4,571	69,286	74,286		177,571	238,429	312,714
3 (N=6)	Min	2,000	0	2,000	0	0	0	4,500
	Max	24,000	15,000	39,000	10,000	52,000	62,000	101,000
	Aver	7,600	4,200	12,300	2,500	11,500	15,100	27,400
4 (N=5)	Min	0	0	6,000	0	0	10,000	24,000
	Max	9,000	28,000	28,000	10,000	40,000	40,000	46,000
	Aver	4,400	10,200	14,600	5,000	16,000	25,000	39,600
8 (N=6)	Min	0	0	4,000	0	0	0	4,000
	Max	12,000	120,000	120,000	12,000	0	12,000	120,000
	Aver	3,000	23,583	27,417	2,333	0	2,333	29,750
9 (N=10)	Min	0	0	1,500	0	0	0	5,500
	Max	7,000	24,000	24,000	5,000	72,000	78,000	84,000
	Aver	2,950	3,800	7,550	3,800	11,100	17,400	24,950
10 (N=79)	Min	0	0	0	0	0	0	4,000
	Max	30,000	400,000	400,000	144,000	506,000	506,000	516,000
	Aver	4,327	9,880	14,801	9,451	56,077	66,780	81,581

1= Contouring, 2= Construction of stone wall, 3= Growing wind breaks, 4= Apply residue back to the field, 8= Mana-ged irrigation, 9= Natural vegetation, 10= Applying FYM or Gypsum

Among ten soil conservation practices considered in the study, only seven of them have costs and the other conservation practices such as leaving fallow and minimum tillage practices have no extra cost. Although there is no extra cost, leaving the land fallow may have the opportunity cost. Similarly, growing pulses in intercropping system alsodid not add any extra cost. It just has to bare the cultivation costs. Therefore, no observation of extra cost for those soil conservation practices. Among seven conservation practices depicted in table 4.6 contouring and construction of stone wall and growing wind breaks could be used for a long term that their costs may spread over years. Then, the cost of conservation would be very low.

4.7 Benefits of Soil Conservation

Almost 30 percent of land was reported as degraded land so that the crop productivity on the degraded land was much lower than that of in the land of normal soil condition (Table 4.7). Various crops have been grown on degraded land and they were such as rice, sunflower, corn, pigeon pea, sesame, blackgram and groundnut in Kyaukpadaung Township and chickpea, cotton, rice, pigeon pea, sesame, greengram and groundnut in Chaung U Township. Average crop yield before the soil has degraded and average crop yield with current soil degradation problem were presented in Table 4.7. Crop losses due to soil degradation ranged from 44-67 percent of the crops and average crop productivity loss percent was 57. Percentage of crop productivity losses ranged from 44 percent in sunflower to 67 percent in pigeon pea and black gram in Kyaukpadaung Township. Crop productivity loss after land degradation in Chaung U Township ranged from 29 percent in groundnut to 70 percent in corn in Chaung U township and average crop productivity loss was 52 percent.

The value of crop loss was assumed to be the benefit for soil conservation for the farmers if and only if they fully conserve their land. It is assumed that farmer would gain their yield potential when their soil is conserved. If the farmer adopts soil conservation practice he would not encounter in crop loss problem. He will harvest at least on average yield for the crop he grew. Therefore, average values for crop losses were estimated for each crop and presented in Table 4.7. The benefits ranged from 42,750-540,000 Ks. per acre in Kyaukpadaung Township and 59,500-413,000 Ks. per acre in Chaung U Township. The average benefits for soil conservation in Kyaukpadaung Township was 278,993 Ks. per acre and in Chaung U Township was 185,715 Ks. per acre.

practices such as managed irrigation cannot be done by individual and it needed to be done by groups of farmers that they mentioned that they need to form water users' association. Although the farmers mentioned that the capital is the most binding constraints for adoption of soil conservation, they also did not know much about the systematic conservation of soil according to the specific problem.

Among 105 respondent farmers about 25 percent of respondents did not get the relevant information for soil conservation technologies and only 75 percent or 80 of them responded the question about the source of information regarding the soil conservation practices. The results were presented in Table 4.8. About 37.5 percent of respondent acquired the relevant information from the extension agents who were assigned by the Department of

Table 4.7. Crops grown and crop losses due to soil degradation in Kyaukpadaung and Chaung U townships.

	Name of crop	N	Yield (Bsk/Ac)			Crop loss in percentage	Price of crop per unit (Ks./Bsk)	Crop loss in value (Ks./Ac)
			Before soil problem	Current yield	Crop loss in volume			
KPG	Rice	38	67	35	32	47.76	4,200	134,400
	Sunflower	6	33.3	18.6	14.6	43.84	5,000	219,000
	Corn	5	12	4.5	7.5	62.50	5,700	42,750
	Pigeon pea	5	30	10	20	66.67	24,000	480,000
	Sesame	5	12.2	4.8	7.4	60.66	32,000	236,800
	Black gram	3	30	10	20	66.67	15,000	300,000
	Groundnut	3	120	60	60	50.00	9,000	540,000
	Average					**57.00**		**278,993**
CHU	Rice	12	84	42.8	41.2	53.3	4,600	189,520
	Cotton	11	150	65	85	56.67	700	59,500
	Pigeon pea	11	25	14	11	44.00	24,400	268,400
	Corn	5	35	10.6	24.4	69.71	7,000	170,800
	Sesame	5	18.6	6.8	11.8	63.44	35,000	413,000
	Greengram	2	8	5	3	37.50	27,000	81,000
	Groundnut	2	70	50	20	28.57	9,000	180,000
	Chickpea	2	14.5	5	9.5	65.52	13,000	123,500
	Average					**52.00**		**185,715**

4.8 Constraints for Adoption of Soil Conservation Practices

Constraints for adoption of soil conservation practices were asked by an open ended question. The answers were organized into six categories. Majority respondents replied that the limited capital was the most binding constraints for practicing soil conservation practice. 59 respondents or 65 percent of respondents has limit in investment capital. 15.4 percent of the respondents said that they would like to know the systematic conservation method. They thought they need training for conserving their land. Small amount of percentage said they needed to care for the working animal, needed crop residues as animal feeds, labor scarcity, etc. Some soil conservation

Agriculture of the respective township. The second mostly used source of information came from co-farmers. Farmers usually exchange the relevant information among them. But, the problem was they copied each other's practice without diagnosing their own soil problem. Sometimes, the cause of problem was totally different but they treatment they took was the same resulting ineffective use of resources. That kind of phenomenon was observed several times that it is highly suggested for very urgent need of training and proper and effective extension service. Several numbers of NGOs were also involving in poverty reduction programs in central dry zone that 11.25 percent of respondents claimed that they

got the soil conservation technologies and support from NGOs. 6.25 percent of people heard the soil conservation techniques through the radio talk shows. Although the schooling years of respondents were found to be as primary education level, they were rich in indigenous knowledge (IK) that 5 percent of farmers said they followed the traditional customs for agriculture as a soil conservation practice and 17.5 percent of respondents used their intuition and IK for the soil conservation (Figure 5).

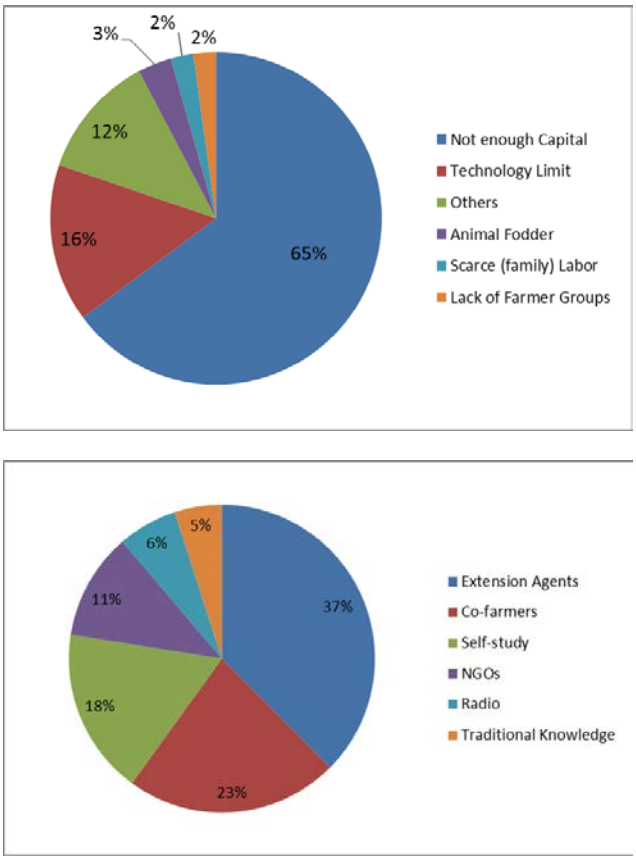

Figure 5. Constraints for and source of information for soil conservation practices in Kyaukpadaung and Chaung U Townships.

5. Conclusion and Policy Recommendation

5.1 Conclusion

Soil loss is not only a problem for the farmer, with the loss of organic matter and fertility; it is also an environmental problem. Soil erosion is a natural process occurring on every landscape [12]. Land degradation problem is very significant and an inevitable one especially in the dry zone region of Myanmar. The study has been conducted with the aim of understanding the constraints for adoption of soil conservation practices, measuring the severity of the land degradation problems, exploring current soil conservation practices being practiced by the farmers, and estimating the costs and benefits for the different conservation methods. About 30 percent of their own land was with land degradation problems and crop losses ranged from 44-66 percent in Kyaukpadaung Twonship and 29-70 percent in Chaung U Township. Majority of respondent farmers claimed that the lack of working capital was the most binding constraint for adopting or practicing soil conservation methods. The second complaint was lack of technology regarding soil conservation. Although average respondent farmer has middle school education they were rich in indigenous knowledge (IK) regarding soil conservation that some respondents used their IK for soil conservation.

The causal factor, which happened most to the soil degradation problem in the study area was water erosion. There are slope on the land and no contour bunds or no natural vegetation along the contour lines worsened the problem. Then, wind erosion followed the water erosion. The traditional cultural practice of land cultivation in central dry zone is cultivating the land into fine particles so that they were blown away when the wind blew. Consequently, the land became more sandy. The other significant problem in Kyaukpadaung Township was deformation of soil structure because of successive practice of rice-rice cropping patterns for more than 40 years. Under the same cropping pattern, especially rice-rice cropping pattern, for a long time put the soil under anaerobic condition for long time, which made soil microbial activities difficult. Finally it resulted in destruction of soil structure. In the land with the soil structure destruction problem, the land was prepared by man only. No tractor or no working animal could enter the plot otherwise they would drown in the soil. The cost and benefit analysis of soil conservation method was conducted in order to roughly estimate the net benefit of soil conservation in the short-term. The results convinced that there would be positive net benefit by conserving the land.

5.2 Policy Recommendations

The farmers were eager to learn their soil problem systematically. The survey group could explain a little bit of the causal factors of land degradation and general measures for conserving their land, and found that their interests were very high. However, the purpose of the survey team was to conduct the survey that there was not enough time to explain very well about the soil problems in detail. Although there are costly land conservation methods such as construction of stone walls, and contour bunds construction, there are many less costly conservation techniques such as zero tillage, fallowing, intercropping, etc., that the majority farmers need to know the simple ways of soil conservation methods. The survey team just got exposure to sample farmers only and there are many other famers who have soil problems and they might want to know about the soil conservation techniques. The study, therefore, strongly suggest to conduct the farmers training programs regarding the soil conservation in the soil problem area urgently.

The other thing was the farmers do not know their soil problems exactly. It would be great if the diagnosis research was conducted for identifying their soil. Then, the treatment measures would be very effective. Then, precision agriculture would be introduced for more efficient utilization of resources. Conservation agriculture is highly recommended for the improvement of degraded soil in order to obtain at least the average productivity from a unit of land.

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