CHAPTER IV

PROFILE OF STUDY AREA

Before studying factors affecting the adoption of on soil conservation measures using organic materials in oil seed crops-based farming system; it is necessary to know the environmental conditions and farming practices at this study area. Therefore, this chapter describes biophysical, socio-economic factors and cropping systems of study area.

4.1 Land characteristic and biophysical conditions

Magway township is located in Dry Zone area. It is the capital of Magway division and approximately 330 miles away north of Yangon and 219 miles south west of Mandalay. It is an area that is accessible by road. Its neighboring townships are Yaenanchaung, Natmauk, Taungdwingyi, Myothit, Sinbaungwe and Minbu. It has an area of 684.22 square miles (1,769.22 square kilometers). The administrative units are 14 wards at urban and 61 village tracts and 214 villages at rural.

4.2 Climate

This area is dry and arid region where day temperature can reach up to 44˚C and the minimum temperature falls down 10˚C. April was the hottest month with the average temperature 45˚C and January was the coolest month with an average temperature of 9˚C. Figure 4.1 shows ten years average monthly maximum and minimum temperature of the study area. The average annual rainfall was about 38

inches (965 mm) with only 73 average rainfall days per year. According to Figure 4.2, we can see the rainfall distribution pattern and number of rainy days in the study area. Although the highest monthly rainfall was 200 mm, there was no rain in some months. September is the highest rainfall but the average number of rainy days was about 12 days. Although June is the highest average number of rainy days (13 days), the average monthly rainfall was only 163 mm. There were two series of humidity measurement. Humidity I (%) was measured at 9:30 MST (Myanmar Standard Time) and humidity II (%) was measured at 18:30 MST. Figure 4.3 shows the two series of humidity of the study area. The average lowest morning and the evening humidity were 50 and 40 during the months of March and April. The average highest morning and evening humidity were 86 and 81 during the months of September and October. Table 4.1 shows the wind direction of the study area for five years (2005-2009). The ten years average highest wind speed was about 25 mph (miles per hour) on April but the highest wind speed was over 30 mph in certain month of this area. Figure 4.4 shows the wind speed of the study area.

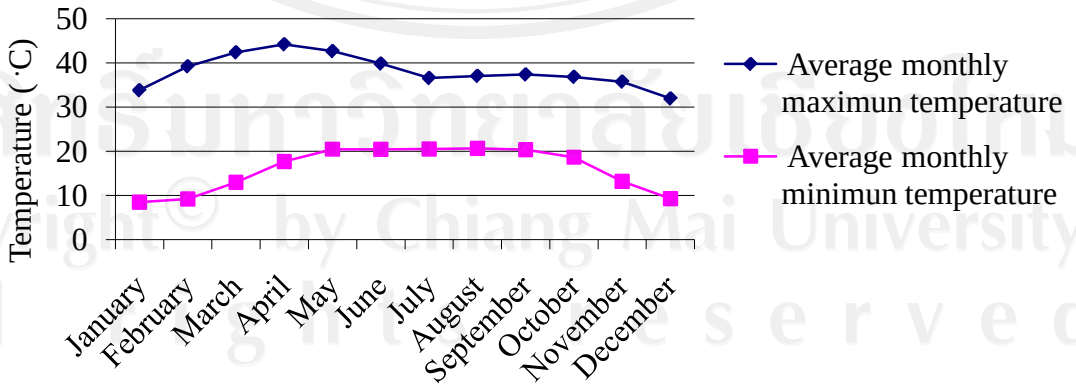

Figure 4.1The average monthly temperature (˚C) of the study area (2000-2009).

Source: Methodological station, Magway division (2010)

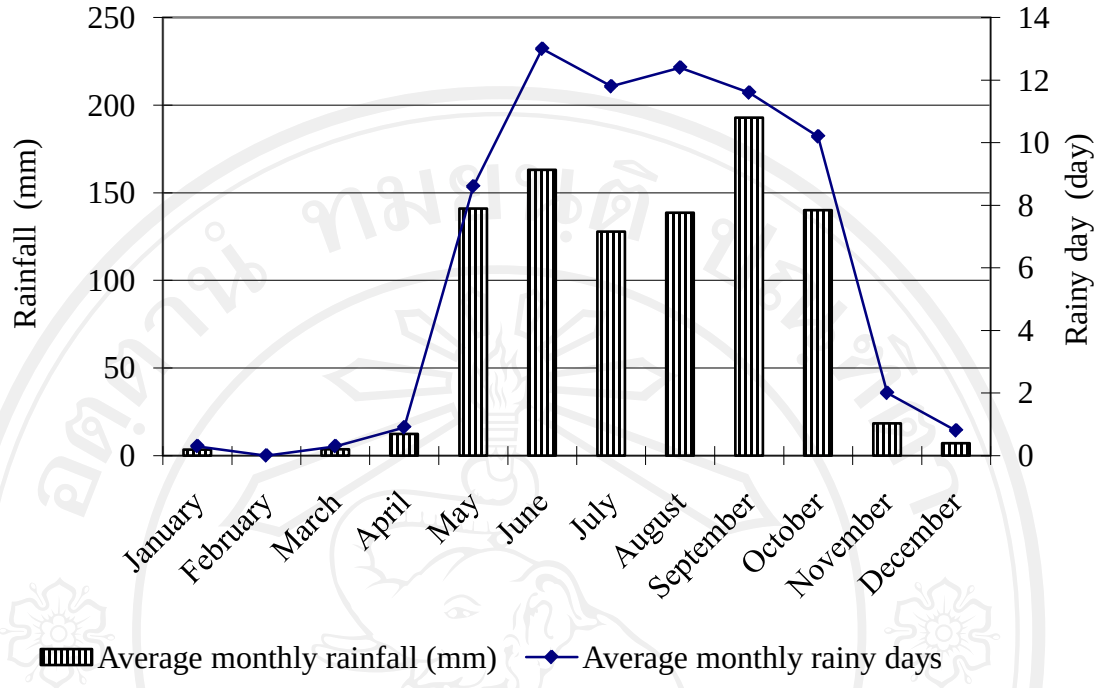

Figure 4.2 Distribution of average monthly rainfall (mm) and rainy days of the study area (2000-2009).

Source: Methodological station, Magway division (2010)

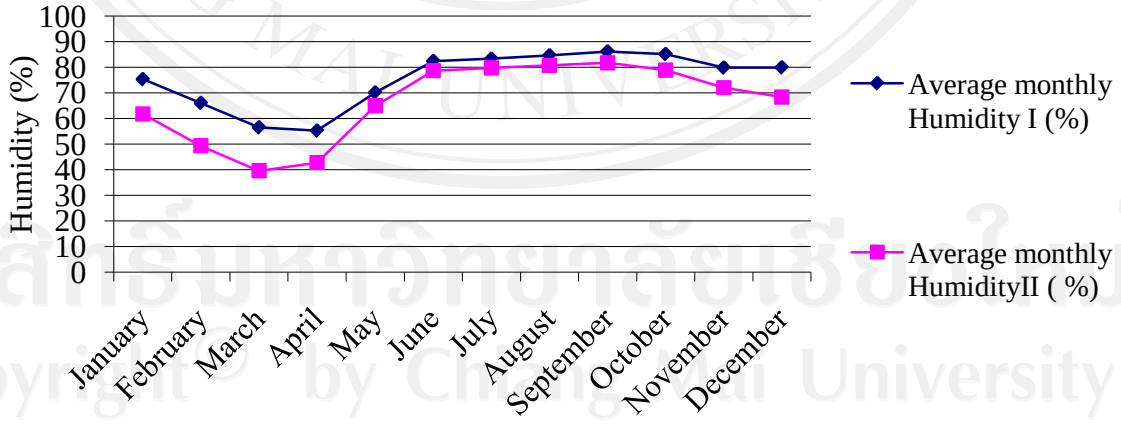

Figure 4.3 The average monthly humidity (%) of the study area (2000-2009).

Source: Methodological station, Magway division (2010)

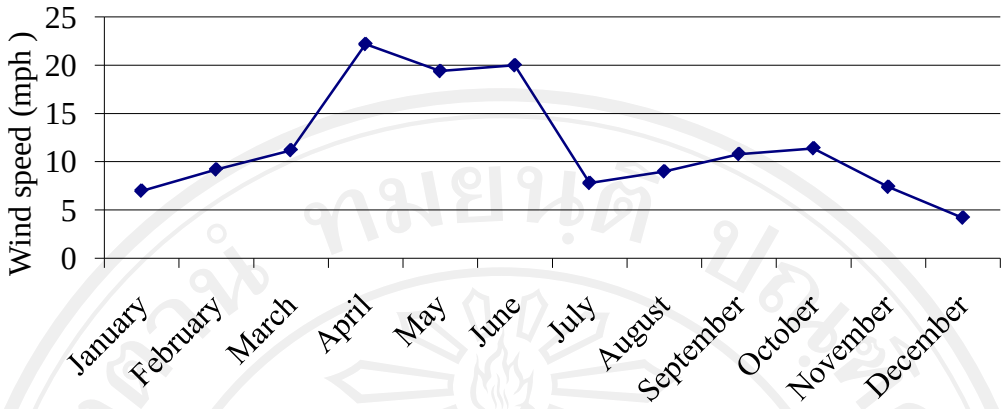

Figure 4.4 The average monthly wind speed of the study area (2000-2009).

Source: Methodological station, Magway division (2010)

Table 4.1The wind direction of the study area for five years (2005-2009)

Months	Direction				
	2005	2006	2007	2008	2009
January	N	N	NE	W	N
February	W	SE	SW	NW	SW
March	SW	E	SW	NW	NW
April	SW	N	NW	SE	E
May	SW	NE	N	SW	NW
June	SW	SW	SW	S	SE
July	SE	S	W	SE	NW
August	SE	SE	SE	SE	S
September	NE	SE	NW	SE	SE
October	SW	NE	NW	NE	SE
November	NW	SE	N	NW	NE
December	NE	NW	S	NE	NE

Source: Source: Methodological station, Magway division (2010)

Note: N = North, S = South, E = East, W = West

4.3 Soil

According to Figure 4.5, the soil type of Magway township is light forest soil. The soil class is fair. The soils are sandy loam and clay loamy with low nutrients, especially N, P and low organic matter contents. Most of the land use type is upland and soil depth is thick. Soil pH is about 7.5 to 8.5. This soil type is suitable to cultivate upland crops such as sesame, groundnut and pulses.

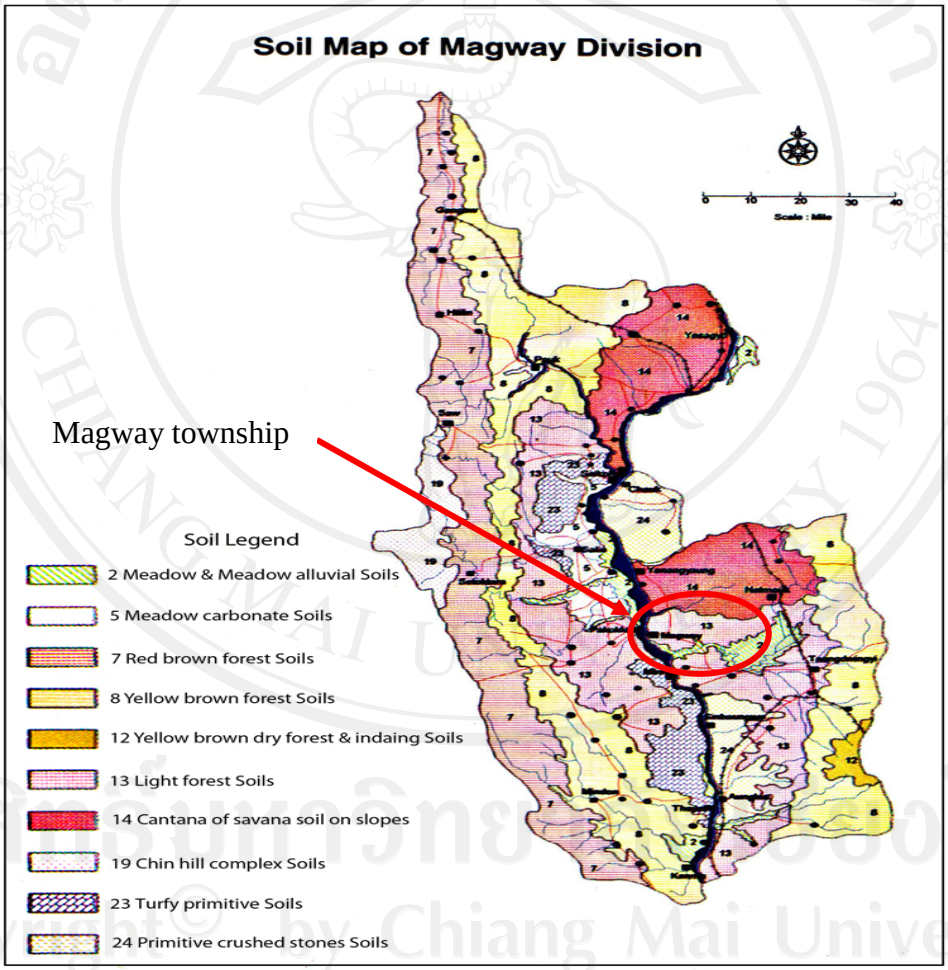

Figure 4.5 Soil map of Magway division.

Source: Soil types and characteristics of Myanmar, MOAI (2004)

4.4 General characteristics of the study area

4.4.1 Land cover and land utilization

The landscape of Magway township is characterized by mostly flat and gently sloping low plains. There are no forests but a large area was covered with sparsely distributed small trees and shrubs. The land utilization of Magway township is shown in Table 4.2. The total land area of Magway township was 436,623 acres (176,770 ha). The upland was 192,204 acres (77,815.4 ha), the lowland was 4,240 acres (1,716.6 ha) and Kaing (crops growing on the alluvial soil) was 4,894 acres (1,981.4 ha) of the total land of Magway township. The upland covered 44 per cent of the total area. The lowland was 1 per cent, the Kaing was 1.1 per cent, the reserved forest was about 1.3 per cent, the cultivated waste land was 0.5 percent and the others area is 52.1 per cent of the total area.

Table 4.2 Land utilization of Magway township

Land Utilization	Acre	Hectare	%
Lowland	4,240	1,716.6	1.0
Upland	192,204	77,815.4	44.0
Kaing	4,894	1,981.4	1.1
Orchard	6	2.4	0.0
Reserved forests	5,600	2,267.2	1.3
Other forest area	174	70.4	0.0
Cultivated waste land	1,978	800.8	0.5
Other lands	227,527	92,116.2	52.1
Total	436,623	176,770	100

Source: MAS (Myanmar Agricultural Service), Magway division (2010)

4.4.2 Major crops sown and their yields

Groundnut and sesame are major crops cultivated in the area. Other crops grown are paddy, sunflower, green gram, black gram, pigeon pea, cowpea, chick pea, lablab beam, chili, onion, potato and cotton. The sown area and production of sesame is the highest. Although the sown area of green gram is second, the production of groundnut is the second highest. The yield of summer paddy (5.2 ton / ha) is higher than the yield of monsoon paddy (4.1 ton / ha). The yield of groundnut shell is 1.9 ton / ha, the sesame is 0.8 ton / ha and the sunflower is 0.7 ton / ha.

Table 4.3 Yield, sown area and production of major crops sown (2009-2010)

Major crops	Yield (ton / ha)	Sown area (ha)	Total production (Ton)
Monsoon rice	4.1	3,054.7	12,646.3
Summer rice	5.2	541.3	2,820.2
Groundnut	1.9	18,649.4	35,060.9
Sesame	0.8	76,271.7	60,254.6
Sunflower	0.7	6,680.6	4,743.2
Green gram	1.2	25,729.9	29,589.5
Black gram	1.6	36.8	58.2
Cowpea	1.0	7,697.2	7,620.2
Chick pea	1.4	881.4	1,189.9
Lablab bean	1.4	2,521.9	3,505.4
Pigeon pea	1.4	13,633.6	19,359.7
Chili	2.3	190.7	446.2
Onion	25.5	763.2	19,437.7
Potato	22.3	69.2	1,541.8
Cotton	1.8	9,676.5	17,514.5

Source: MAS (Myanmar Agricultural Service), Magway division (2010)

Green gram yield is 1.2 ton / ha, black gram yield is 1.6 ton / ha, cowpea yield is 1 ton / ha. Moreover, the yields of chick pea, lablab bean, pigeon pea are 1.4 ton / ha. Chili yield is 2.3 ton / ha. Onion yield is 25.5 ton / ha. Potato yield is 22.3 ton / ha and cotton yield is 1.8 ton / ha. Table 4.3 shows the yield, sown area and production of some major crops sown.

4.4.3 Varieties of some major crops

In the study area, farmers grow different crop varieties shown in Table 4.4. Among the rice varieties, namely Manawthukha, Shwemyanmar, Sinthwelat, Theehtatyin, Shwethweyin, Pakanshwewar, Sinnweyin, Yat90Saba, farmers preferred to grow Manawthukha because of relatively high yield and good market demand. Therefore, the sown area of this variety was the highest followed by Shwemyanmar and Theehtatyin respectively. Among the groundnut varieties, there are Magway 11, Magway 12, Magway 15, Tonterni, Sinpathadar 6, Sinpathadar 7, Sinpathadar 8 and Kyaungkone variety with the sown area of Tonterni was the highest in the rainy season. However, the sown area of Magway 15 is the highest in the winter season. The sesame varieties were Sapphyu, Shwetasoke, Bapan, Gwanatkyaw, Yathaekyaw, Kaweleni, Sinyadanar 3 and Sinyadanar 8. Among them, most of the farmers grew Shwetasoke variety for both the rain and the summer season. In the winter season, they grew Sapphyu and Kaweleni. As for sunflower, farmers grew only Sinshwekya 2 variety for both the rainy and the winter season. Green gram varieties were Yezin 1, Yezin 4, Yezin 5, Yezin 6 and Sitepyoyae 1. Pigeon pea varieties were Ngasanpe and Shwedingar. Farmers preferred to grow only Yezin 3 for black gram.

Table 4.4 Varieties of some major crops

Crops	Varieties
Rice	Manawthukha, Shwemyanmar, Sinthwelat, Theehtatyin, Shwethweyin, Pakanshwewar, Sinnweyin, Yat90Saba
Groundnut	Magway 11, Magway 12, Magway 15, Tonterni, Sinpathadar 6, Sinpathadar 7, Sinpathadar 8, Kyaungkone
Sesame	Sapphyu, Shwetasoke, Bapan, Gwanatkyaw, Yathaekyaw, Kaweleni, Sinyadanar 3, Sinyadanar 8
Sunflower	Sinshwekya 2
Green gram	Yezin 1, Yezin 4, Yezin 5, Yezin 6, Sitepyoyae 1
Pigeon pea	Ngasanpe, Shwedingar
Black gram	Yezin 3

Source: MAS (Myanmar Agricultural Service), Magway division (2010)

4.4.4 Cropping systems and cropping patterns

Most of the farmers prepare their lands using draught animals. They follow the traditionally farm managements practices including summer furrows for weed control, collecting and saving waters when the rain comes but this summer furrows lead to soil erosion by wind. Minimum tillage is practiced during the land preparation for water saving and also intercultivating of crops is done for weed control and soil ventilation. The farmers practice weeding at least two times by hand and hoe weeding combined with intercultivation during the crop period.

Multiple cropping is generally practiced to save the total crop failure by uncertain rainfall pattern. Mixed cropping, intercropping and relay-planting are also common in the study area shown in Table 4.5. However, it may vary from one village to another according to the distribution of annual rainfall and the choice of farmer to optimize the benefit in season's favor such as double cropping and relay planting,

otherwise intercropping as a strategy of risk reduction in case of dry spell during mid-monsoon. Double cropping is the main pattern (first sesame, then other crops) except for pigeon pea, runner type of groundnut, green gram, sorghum and cowpea because these crops are short duration crops and bilateral crops. Therefore, sesame, groundnut, green gram, cowpea are majors crops in this area.

Table 4.6 shows the cropping patterns of the study area. Pigeon pea is intercropped with others. The farmers in this area practice fallowing because this may be mainly due to the insufficient moisture for growing. Oil seed-based cropping system predominates in this area. Rice fields are also found in the irrigated area but it is a small amount comparing with the upland area. Most of the farmers in this area depend on the rain-fed conditions. Among the oil seed crops, sesame and groundnut are the major oil seed crops. Early monsoon sesame and groundnut (erect type) are grown in May and harvested in July. Most of the pulses are sown from September to February depend on the crop duration. Late sorghum is planted as a second crop mainly for animal feed. Vegetable growing is found on the bank of rivers and streams. Among the vegetables, tomato is the most valuable cash crop planted in this area.

Table 4.5 Intercropping and sequential cropping patterns in Magway township

Season	Intercropping patterns	Sequential cropping patterns
Early Monsoon	Sesame + pigeon pea, green gram	Sesame – green gram
Early Monsoon	Groundnut + sunflower	Sesame – sorghum
		Sesame – cowpea
		Sesame – groundnut
		Groundnut – fallow

Source: Survey data (2010)

Table 4.6 Major cropping patterns in the study area

Cultivated Crops			Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Major	Intercropping	Multiple												
Sesame (E) or Groundnut		Groundnut Sorghum Sesame (L) Pulses Onion Tomato Chili Sunflower Niger												
	Pigeon pea													
Rice		Rice												

Source: Survey data (2010)

Note: E = Early, L = Late

4.5 Socio-economic profile of Magway township

The socio-economic profile of Magway township is shown in Figure 4.6. Agriculture sector is 45 per cent, livestock sector is 2 per cent, fishery sector is 2 per cent, causal labor is 47 per cent, small business is 2 per cent and others are 2 per cent of the total population. There is a general scarcity of labour opportunities. More than 90 per cent of the population is dependent on causal labour and agriculture for their survival. The township is densely populated and most of the populations live in rural area. The estimated population is 390,218 and the urban population is 93,876 and rural population is 296,342. Female population is 197,854 and male population is 192,364. Female population is slightly higher than male population. Among the population, the population less than one year old age is 9583 and less than 5 years is 47,599. The population density is 214.27 sq km.

Food security is a year round concern and particularly during the period before harvest, where employment opportunities are limited. Rural communities have limited access to resources, especially land and water, as well as income generating opportunities. Moreover, the growth of population in the area has also resulted in shortage of fuel wood and other biomass sources. Communities are increasing using cow-dung and crop residues such as paddy stalks, sesame stalk and pigeon pea stem, etc. for cooking and parboiling, thus depriving the soil of some natural fertilizers containing essential nutrients.

The main constraint to agriculture is the damage to crops due to the delayed rains and the remaining is the loss of crops due to pests and the inability to afford basic agricultural inputs. It is crucial to note that most of the farmers have no access to irrigation systems.

According to the current price on May, 2010, total cost per acre, total income per acre and net income per acre of some major crops were shown in Table 4.7. According to these data, although onion growing had the highest total cost per acre, the net income per acre was not high. Potato growing was the second highest total cost per acre but it was the highest net income per acre. The total cost per acre of monsoon rice and summer rice were not much different but the net income per acre of summer rice was higher than that of monsoon rice. Moreover, monsoon rice growing was the lowest net income per acre among all crops.

Among the oil seed crops, total production cost per acre of groundnut was the highest followed by sesame and sunflower. However, the net income per acre of groundnut was the highest followed by sunflower and sesame Therefore, among the oil seed crops; groundnut seemed the best crop because although groundnut production cost was relatively high, it was the most benefit.

Among the pulses, although green gram growing was the highest production cost per acre followed by the black gram, pigeon pea and chick pea, the highest net income per acre got from pigeon pea growing followed by black gram, chickpea and green gram.

According to the net income per acre, the best crop was potato followed by pigeon pea, black gram, chick pea and groundnut in Magway township. These production cost, total income and net farm income per acre were calculated based on rain fed crops except summer rice. Summer rice was an irrigated crop. However, these net incomes per acre can be varied depending on the market situation. These net incomes were calculated for May 2010. The farmers grow these crops depending on the market situation. Their preference can vary year to year due to market prices.

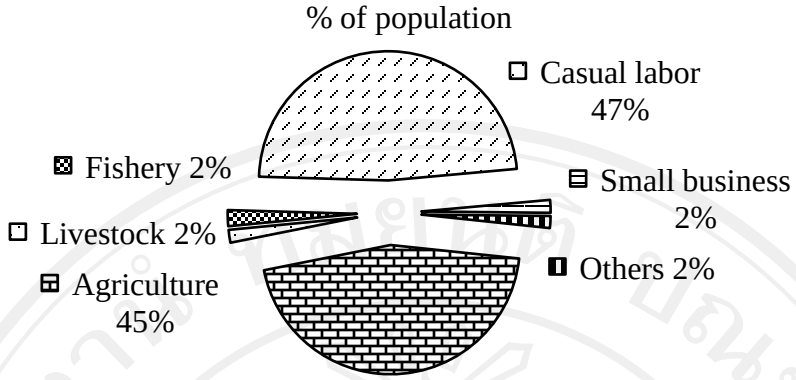

Figure 4.6 Socio-economic profile of Magway township.

Source: MAS (Myanmar Agricultural Service), Magway division (2010)

Table 4.7 Production cost, total income and net income of major crops (May, 2010)

Crops	Total cost / acre (Kyats)	Total income / acre (Kyats)	Net income / acre (Kyats)
Rain fed crops			
Monsoon rice	263,500	360,765	97,265
Corn	196,600	323,253	126,653
Groundnut	188,500	438,720	250,220
Sesame	158,260	232,990	74,730
Sunflower	77,600	127,139	49,539
Green gram	177,590	310,770	133,180
Pigeon pea	133,090	465,000	331,910
Black gram	169,340	512,190	342,850
Chick pea	123,500	334,000	210,500
Onion	936,200	1,392,475	456,275
Chilli	157,000	245,024	88,024
Potato	639,750	5,147,860	4,508,110
Cotton	205,975	434,827	228,852
Irrigated crop			
Summer rice	268,500	431,865	163,365

Source: MAS (Myanmar Agricultural Service), Magway division (2010)

Note: 1000 Kyats = 1 US$ (May 2010); 2.47 acre = 1 ha

4.6 The characteristics of the sampled farm households

4.6.1. Socio-economic characteristics of sampled respondents

Among the respondents, the majority are male whereas only small numbers were female. The male percentage of sample respondents was 96.4 per cent because household heads were selected as sample due to purposive sampling. It was observed that large proportions were male leader and they managed the farming and they were also the head of the family. The average age of the responds was 47.2 years. The youngest farmer was 26 years and the oldest farmer was 76 years. The average education level was nearly 8 years. Some farmers had high education level. The maximum education level was 16 years and the minimum was 3 years. Most of the farmers had good experiences in farming. The average year of farming experience was 25 years. Most of the farmers were native. Only 4 per cent of farmers were immigrants (Table 4.8).

More than 90 per cent of the population was depend on agriculture for their survival. The minimum farm income was 150,000 kyats per year and the maximum farm income was 30,000,000 kyat per year. Some families did not have off-farm income and the maximum off-farm income was 3,600,000 kyats per year. Both farm income and off-farm income varied from farmer to farmer. Therefore, these incomes were divided into three level; low (less than 50 lakh kyats), medium (50 to less than 100 lakh kyats) and high (equal or more than100 lakh kyats) for farm income and low (less than 10 lakh kyats), medium (10 to less than 20 lakh kyats) and high (equal or more than 20 lakh kyats) for off-farm income. One lakh kyats equals to 100,000 kyats (100 US$). Figure 4.7 shows that most of the farmers (84.2 per cent) had low level, 9.7 per cent of farmers had medium and the remaining 6.1 per cent of farmers had

high level farm income and 91.5 per cent of farmers had low, 6.1 per cent of farmers had medium and 2.4 per cent of farmers had high level off-farm income.

All the family members participated in farming practices. 97 per cent of the household heads worked in farming as full time workers. Only 3 per cent of farmers were part time farm workers. 97 per cent of the households owned their farms and a small number (3 per cent) were tenant farmers. Figure 4.8 shows the percentage of sample farmers' farming status and land tenure.

Table 4.8 Age, sex, ethnic group, education and experience in farming of sampled households

Characteristics	Unit	Mean n =165	Minimum	Maximum	Standard deviation
Age of respondent	No. year	47.2	26	76	10.9
Education level	No. year	7.9	3	16	3.2
Experience in farming	No. year	25.0	4	58	12
Sex (Male)	%	96.4			
Ethnic group (Native)	%	96.0			

Source: Survey data (2010)

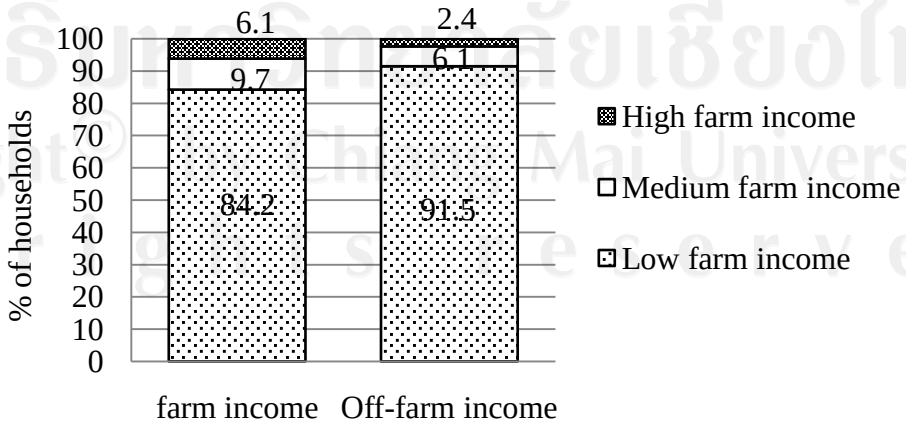

Figure 4.7 The percentage of sampled farmers' farm and off-farm income level.

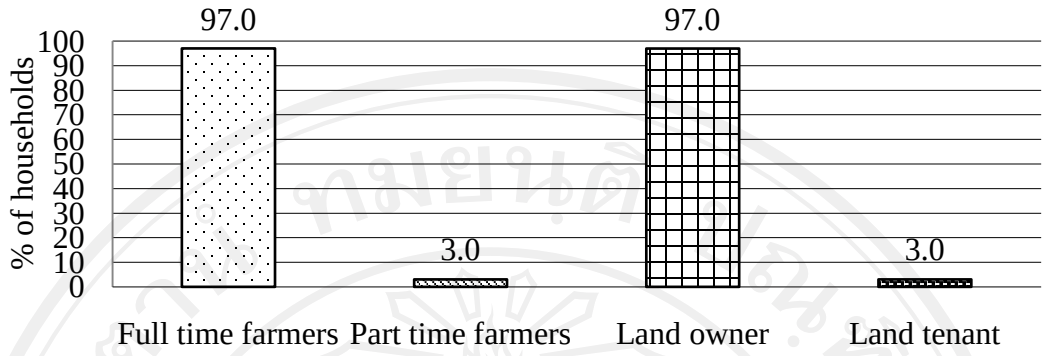

Figure 4.8 The percentage of sampled farmers' farming status and land tenure.

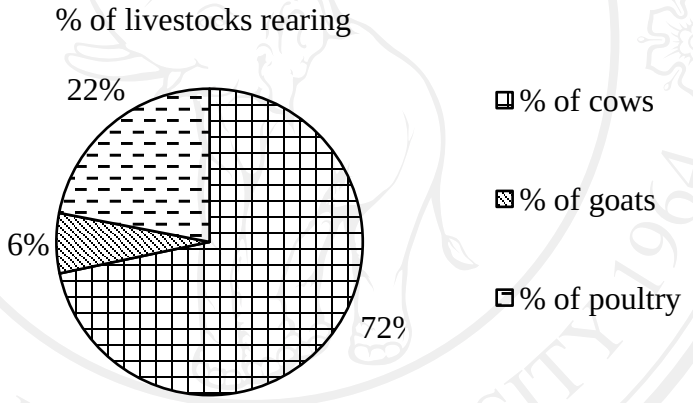

Figure 4.9 The percentage of livestock rearing.

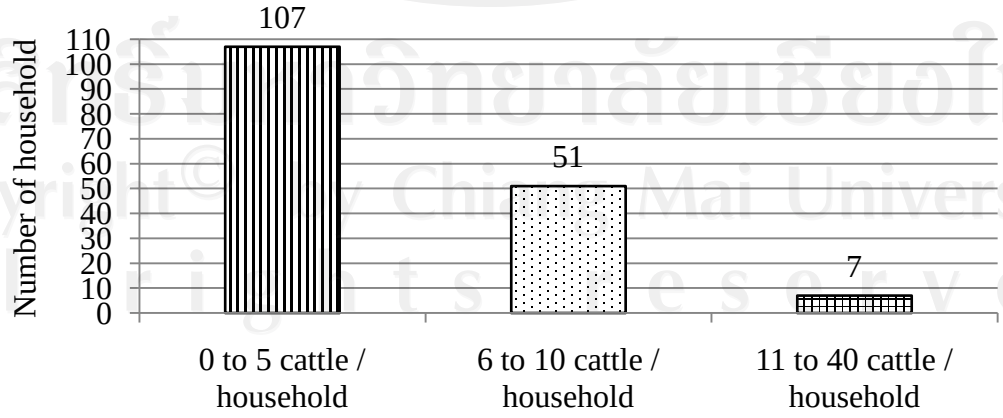

Figure 4.10 Frequency distribution of cattle numbers.

Livestock was very important. Most of the farmers owned cattle because cattle were mainly used for draught power, transportation of farm products and for land preparation. The number of cattle owned was based on the feed and water availability. The average number of cattle owned by the farmers was about 5 heads. Only a few farmers did not have cows. The farmers owned maximum 15 cows and 30 goats. Farmers owned more cows than the goats and poultry. According to Figure 4.9, 72 per cent of livestock rearing was cow rearing, 22 per cent was poultry rearing and only 6 per cent was goat rearing. Figure 4.10 shows the frequency distribution of cattle numbers. Among the respondents, 107 respondents owned 0 to 5 cattle, 51 respondents owned 6 to 10 cattle and only 7 respondents owned 11 to 40 cattle.

4.6.2 Bio-physical factors facing the sampled households

Farms owned by farmers ranged from 2.5 to 80 acres. The average number of farm size is 16 acres. Among the respondents, 100 households had 0 to 15 acres, 49 households had 16 to 30 acres, 10 households had 31 to 45 acres, 5 households had 46 to 60 acres and only the remaining 1 respondent had 80 acres (Figure 4.11). Therefore, it can be seen that most of the farmers were small scale farming. The average amount of fodder using the crop residues was 17.8 ton / year. The maximum amount of crop residues used as fodder was 54 ton / year. Farmers also used crop residues for fuel burning. The average amount crop residues used as fuel burning were 7.2 ton / year. The amounts of crop residues range from 2.8 ton / year to 15 ton / year were used for burning every year. Over half of the sampled farmers' farms were good soil fertility. The percentage of good soil was 64 per cent and poor soil was 36 per cent (Table 4.9). Figure 4.12 shows the percentage of sampled farmers having sandy

soil. About 75 per cent of farm lands were sandy soil and only 25 per cent of farms were not sandy soil.

Table 4.9 Farm size, soil fertility, crop residues used as fodder and fuel of sampled households

Bio-physical factors	Unit	Mean n = 165	Min.	Max.	Standard deviation
Farm size	Acre	16.0	2.5	80.0	12.2
Crop residues used as fodder	Ton / year	17.8	0	54	11.4
Crop residues used as fuel	Ton / year	7.2	2.8	15	2.7
Good soil fertility	%	64			
Poor soil fertility	%	36			

Source: Survey data (2010)

Figure 4.13 shows the percentage of sampled farmers having different farm slope types. Most of the farms (90.3 per cent) were flat land (0-2% slope). Only 9.1 per cent of farms were gentle slope (2-5% slope). The remaining 0.6 per cent of farms were high slope (>5% slope). All the farmers in this area depend on the rain for growing, especially upland crops. According to Figure 4.14, 99.4 per cent of households faced water scarcity. Some farmers accessed irrigation by river pumping especially for growing rice. But irrigation was insufficient. Only 35.8 per cent of farmer accessed good irrigation and 12.1 per cent of farmers accessed partial irrigation. The remaining 52.1 per cent of farmers did not access any irrigation (Figure 4.15). Erosion was rare in their farm. Only 1.2 per cent of farms were high soil erosion and 8.5 per cent of farms were medium soil erosion. The remaining 90.3 per of farms were low soil erosion status (Figure 4.16).

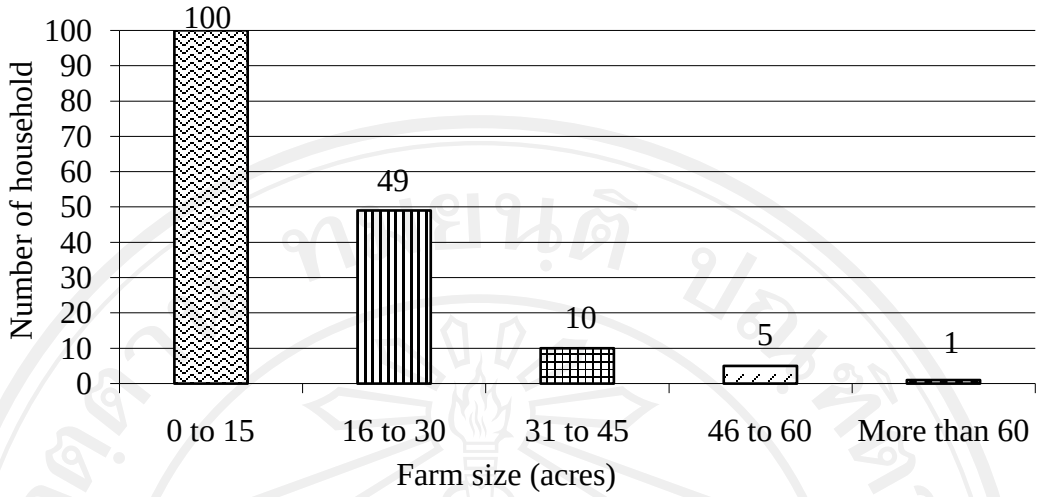

Figure 4.11 Frequency distribution of farm size.

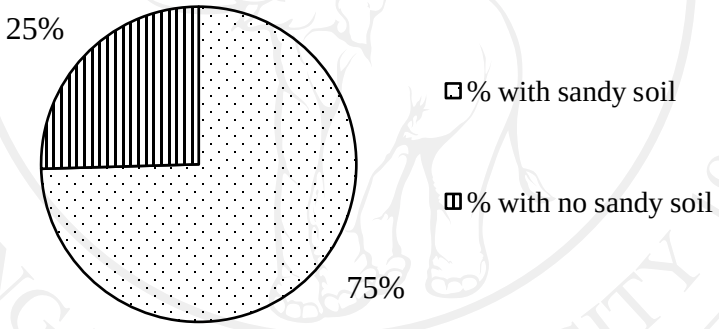

Figure 4.12 The percentage of sampled farmers having sandy soil.

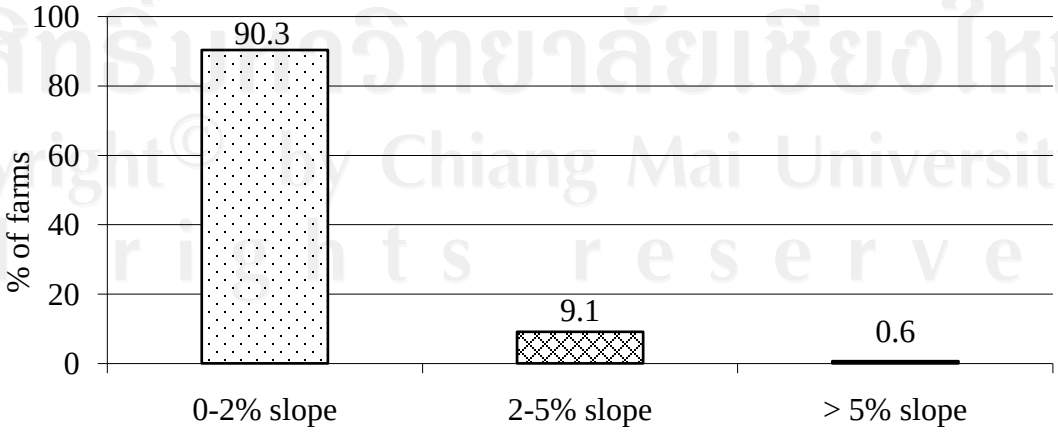

Figure 4.13 The percentage of sampled farmers having different farm slope types.

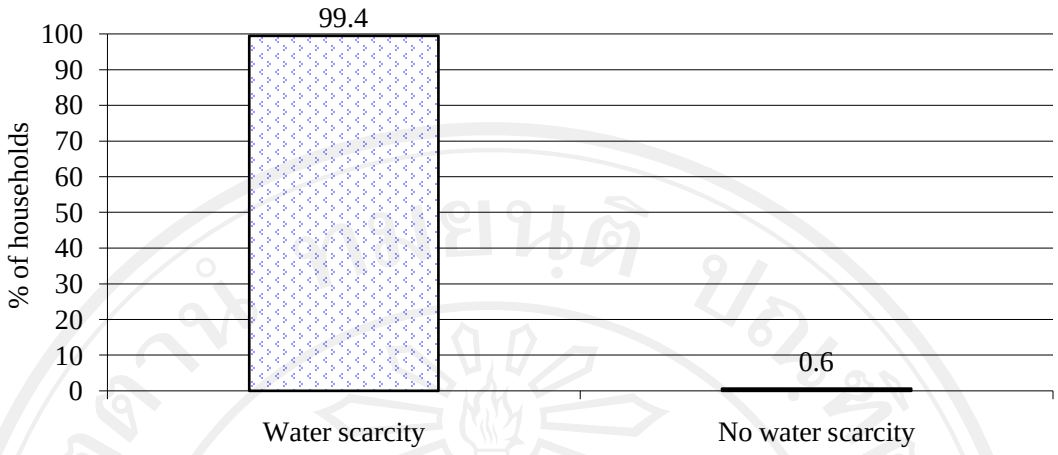

Figure 4.14 The percentage of sampled farmers having water scarcity.

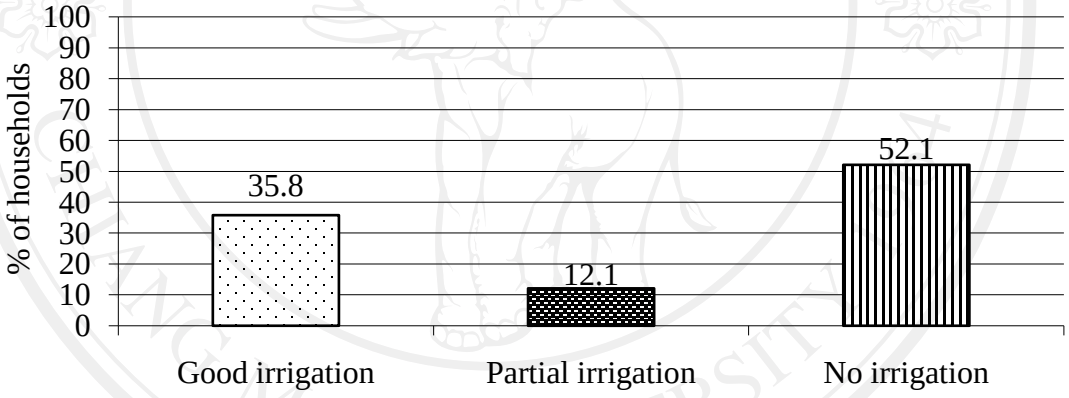

Figure 4.15 The percentage of sampled farmers having different irrigation access.

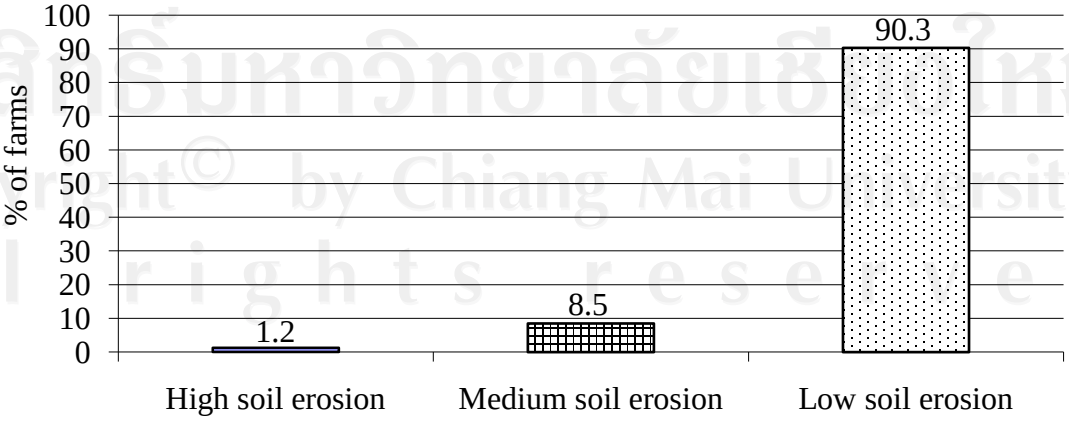

Figure 4.16 The percentage of sampled farmers having different soil erosion status.

4.6.3 Technological factors among the sampled households

According to Table 4.10, the average of farmers' knowledge was 25.4 score. Minimum score was 3 and maximum score was 43. These scores were calculated by asking about 13 questions relating to the soil conservation measures, soil degradation and erosion status. The total score for 13 questions ranged from 0 to 58. Thirteen questions to determine farmers' knowledge on soil conservation, soil degradation and soil erosion status were as follows;

1. Do you know your field's soil condition?
2. Are you aware about the soil erosion in your field?
3. Do you know which factors affect to lead soil erosion in your field?
4. Have you ever seen any types of erosion form in your field?
5. Do you think it is difficult to land preparation in severe soil erosion field?
6. Do you know the effects of soil erosion?
7. Did you try to reduce the soil erosion problems in your field?
8. Do you know the causes of land degradation?
9. Do you know the advantages of the application of crop residues and green manure?
10. Do you know the advantages of the application of FYM and animal manure?
11. Do you know the problems of post harvest plowing in sandy loan soil?
12. Do you know the advantages of legumes intercropping with other crops?
13. Do you know the advantages of rotation with legumes?

The average scores responded by the sampled farmers to each question are shown in Table 4.11. For question number (1), 98.8 per cent of sampled households knew their field condition. The average score was 2.9. The minimum score was 0 and

maximum score was 5. For question number (2), only 8.5 per cent of households were not aware about the soil erosion in their fields and 91.5 per cent of households were aware this problem. For question number (3), 86.1 per cent of sampled households knew the factors affecting soil erosion in their fields. The average score was 1.6. The minimum score was 0 and maximum score was 2. For question number (4), 51.5 per cent of sampled households had ever seen some types of erosion form in their fields. The average score was 0.6. Minimum score was 0 and maximum score was 2. For question number (5), 61.8 per cent of sampled households thought that it was difficult to prepare their land if the fields were severe soil erosion. The average score was 0.9. Minimum score was 0 and maximum score was 2. For question number (6), 92.1 per cent of sampled households knew the effects of soil erosion. The average score was 2.6. Minimum score was 0 and maximum score was 4. For question number (7), 83.6 per cent of sampled households tried to reduce the soil erosion problems in their fields. The average score was 1.8. Minimum score was 0 and maximum score was 4. For question number (8), 93.3 per cent of sampled households knew the causes of land degradation. The average score was 2.9. Minimum score was 0 and maximum score was 5. For question number (9), 95.8 per cent of sampled households knew the advantages of application of crop residues and green manure growing. The average score was 3.9. Minimum score was 0 and maximum score was 8. For question number (10), all sampled households knew the advantages of the application of farm yard manure and animals' manure application. The average score was 3.4. Minimum score was 1 and maximum score was 6. For question number (11), only 11.5 per cent of sampled households knew the problems of post harvest plowing in sandy loam soil. The average score was 0.2. Minimum score was 0 and maximum score was 3.

Table 4.10 Knowledge, cropping intensity and extension visit of sampled households

Technology factors	Unit	Mean (n =165)	Min.	Max.	Standard deviation
Knowledge	Score	25.4	3	43	7.0
Cropping intensity	Index	217.1	150	296	25.6
Extension visit	Time / year	6.9	2	17	3.0

Source: Survey data (2010)

Table 4.11 The percentage, average, minimum and maximum score of farmers' knowledge on each question

Question Number	% of households		Mean score (n = 165)	Knowledge score		Standard deviation
	Yes	No		Minimum	Maximum	
1	98.8	1.2	2.9	0	5	0.9
2	91.5	8.5				
3	86.1	13.9	1.6	0	2	0.7
4	51.5	48.5	0.6	0	2	0.6
5	61.8	38.2	0.9	0	2	0.8
6	92.1	7.9	2.6	0	4	1.1
7	83.6	16.4	1.8	0	4	1.1
8	93.3	6.7	2.9	0	5	1.3
9	95.8	4.2	3.9	0	8	1.7
10	100	0	3.4	1	6	1.1
11	11.5	88.5	0.2	0	3	0.6
12	76.4	23.6	1.4	0	4	1.1
13	95.8	4.2	2.3	0	4	0.9

Source: Survey data (2010)

For question number (12), 76.4 per cent of sampled households knew the advantages of legumes intercropping with other crops. The average score was 1.4. Minimum score was 0 and maximum score was 4. For question number (13), 95.8 per

cent of sampled households knew the advantages of rotation with legumes. The average score was 2.3. Minimum score was 0 and maximum score was 4.

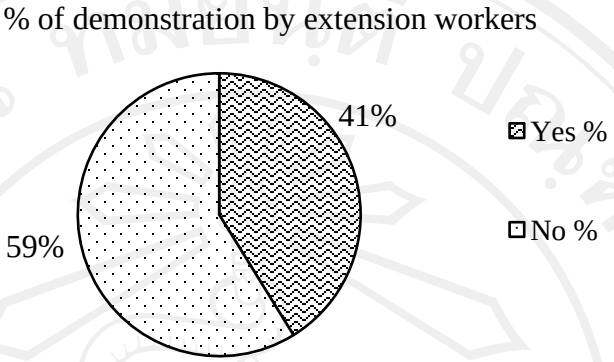

Figure 4.17 The percentage of demonstration by extension workers.

Extension workers (GOs & NGOs) normally visited about 7 times per year. The minimum visited times was 2 times and maximum visited times was 17 times per year. Extension workers demonstrated some relevant technology to only 41 per cent of farmers shown in Figure 4.17. Most of the farmers grew double and intercropping systems because the average cropping intensity index was 217.1. The minimum cropping intensity index was 150 and maximum was 296.

4.7 Farmers' knowledge on soil conservation

Farmers' knowledge on soil conservation was measured by asking 13 questions related to the soil conservation measures, soil degradation and erosion status. The total score for 13 questions ranged from 0 to 58, with results classified into three levels using the class interval of Harshbarger, 1977.

Farmers' knowledge of soil management is important. All the farmers interviewed had some knowledge of soil in term of their spatial heterogeneity,

physical properties and response under different cultivation practices. Among the farmers, only 2.4 per cent of farmers had a high score level of knowledge (39-58) while about 81.2 per cent of farmers had a medium score level of knowledge (20-38) and 16.4 per cent of farmers had a low score level of knowledge (0-19). Figure 4.18 shows the percentage of farmers' knowledge on soil conservation practices.

All the farmers knew how the soil differed in their fields in term of depth, texture, structure, color and drainage. Farmers described variation using either a local term, a textual (e.g. sandy, silty) and they had also a practical "working knowledge" through regular cultivation which enabled them to judge its structure and condition. Accordingly, soils were often described by farmers in terms of their ease of cultivation, with terms such as "light and easy" or "heavy" used. Some drew relationships between soil texture, structure and soil moisture, distinguishing heavier soils as having better natural structure and better retention but being more difficult to plough. They understood the positive effect of manure in improving and maintaining soil fertility conditions and continuous provision of long-term nutrients for crops. Therefore, most of the farmers applied the farmyard manure for soil improvement and maintenance. Farmyard manure was typically applied as a mixture of animal dung, urine and farm waste materials. The main source of animal dung in the study area was cattle dung. Usually, the farmers collected FYM monthly and kept it in pits. Before application the manure usually decomposed in these pits. FYM was applied during land preparing as basal fertilizer.

High score-level farmers, a few farmers, had knowledge about both scientific knowledge and local knowledge for soil conservation practices such as advantages of the application of FYM, crop residues, green manure and compost. They also knew

the benefit of intercropping and rotation practices for soil fertility improvement and maintenance. They also well knew that crop rotation in addition to fertility restoration and soil and water conservation was a popular traditional practice of controlling diseases, pests and weeds infestation. It was well known that different crops were not equally susceptible to the same pests or diseases. Growing the same crop year after year would provide an opportunity for pests to multiply and outbreak virulently after two or three years of continuous cultivation, eventually leading to serious loss of crop yield. The same problem held true for weed infestation. Moreover, they also knew that relay cropping; before sorghum was harvested some legume crops might be sown in between rows and then grew on the residual moisture. Once some biomass or grain was produced, the crop residues were incorporated into the soil for future. Besides they knew how to control for reducing the soil erosion and which factors affected the soil erosion and soil degradation. They tried to reduce soil erosion problem in their fields by doing contour tillage, building the bunds and growing the wind break. These farmers got this knowledge through their experiences and also from the private and public extension workers, especially UNDP project.

Medium score-level farmers did not know which factors affected the soil erosion and soil degradation. Therefore, these kinds of farmers practiced post harvest ploughing the soil during the summer duration. They thought that this practice was advantageous to control weed and to save water when the rain comes. They did not know this practice could lead to soil erosion by wind and could decline the soil fertility because the soil was opened. Most of the farmers in the study area followed this practice. Besides, they were not aware the soil erosion in their fields.

Low score-level farmers had knowledge only few advantages of incorporating cow dung and intercropping and rotation practices for soil fertility improvement and maintenance.

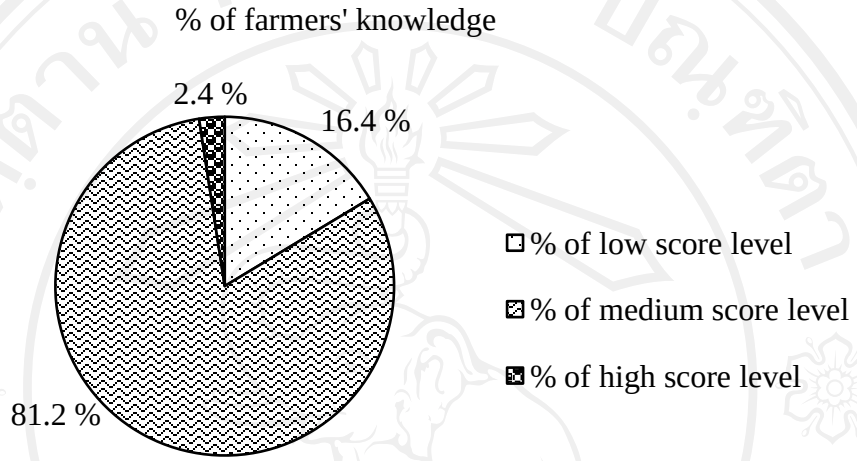

Figure 4.18 The percentage of farmers' knowledge on soil conservation practices.

4.8 Comparison the adopters and non-adopters of conservation practices using organic matters according to the cropping patterns

Among surveyed households, 88 households (53.3 per cent) used crop residues, 62 households (37.6 per cent) applied compost and only 25 households (15.1 per cent) grew green manure for soil conservation. According to Table 4.12, 163 farmers adopted the oil seed-legume cropping pattern. Among the oil seed-legumes adopters, 87 respondents (53 per cent) adopted to use crop residues for soil conservation and the remaining 76 respondents (47 per cent) were non-adopters of crop residues application for soil conservation. Besides, 61 respondents (37 per cent) adopted and the others 102 respondents (63 per cent) did not adopt to apply compost. Moreover, 25 respondents (15 per cent) adopted and 138 respondents (85 per cent) did

not adopt to grow green manure. Only two respondents did not grow the oil seed-legume cropping pattern. One was adopter and another one was non-adopter to use crop residues and compost for soil conservation but these two respondents did not adopt to grow green manure for soil fertility improvement.

Out of total respondents, 157 responds adopted the oil seed-cereal cropping pattern. Among them, 82 respondents (52 per cent) adopted and the remaining 75 respondents (48 per cent) did not adopted to use crop residues for soil conservation. There were also 60 adopters (38 per cent) and 97 non-adopters (62 per cent) for applying compost. Moreover, there were 25 adopters (16 per cent) and 132 non-adopters (84 per cent) for growing green manure crops.

Only 8 respondents did not grow the oil seed-cereal cropping pattern. Among them, 6 respondents (75 per cent) adopted and 2 respondents (25 per cent) did not adopted to use crop residues for soil improvement. Oppositely, 2 respondents (25 per cent) adopted and 6 respondents (75 per cent) did not adopt to apply compost for soil improvement. However, all non growers of oil seed-cereals did not adopt to grow green manure for soil conservation and improvement.

On the other hand, there were only 5 respondents grew the oil seed-vegetable cropping pattern and 160 respondents did not grow oil seed-vegetables cropping pattern. Among the oil seed-vegetables growers, 2 respondents (40 per cent) adopted and 3 respondents (60 per cent) did not adopted to use the crop residues for soil conservation. However, all growers of oil seed-vegetable cropping pattern did not adopt to apply compost and to grow green manure crops for soil improvement. Among the non-growers of oil seed-vegetable cropping pattern, 86 respondents (54 per cent) adopted and 74 respondents (46 per cent) did not adopted to use the crop

residues for soil conservation. Besides, 62 respondents (39 per cent) adopted and 98 respondents (61 per cent) did not adopt to apply compost for soil improvement. Similarly, 25 respondents (16 per cent) adopted and 135 respondents (84 per cent) did not adopt to grow green manure for soil conservation and improvement.

Table 4.12 Comparison the adopters and non-adopters of crop residues application, compost application and green manure growing by the cropping patterns

Conservation practices		Oil seed-legume				Oil seed-cereal				Oil seed-vegetable			
		Yes (163)		No (2)		Yes (157)		No (8)		Yes (5)		No (160)	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
CR	Adopt (n=88)	87	53	1	50	82	52	6	75	2	40	86	54
	Not adopt (n=77)	76	47	1	50	75	48	2	25	3	60	74	46
CP	Adopt (n=62)	61	37	1	50	60	38	2	25	0	0	62	39
	Not adopt (n=103)	102	63	1	50	97	62	6	75	5	100	98	61
GM	Adopt (n=25)	25	15	0	0	25	16	0	0	0	0	25	16
	Not adopt (n=140)	138	85	2	100	132	84	8	100	5	100	135	84

Source: Survey data (2010)

Note: CR = crop residues application, CP = compost application and GM = green manuring

According to the cropping patterns, the farmers' adoption to use crop residues varied. Among the three cropping patterns; namely oil seed-legume cropping pattern, oil seed-cereal cropping pattern and oil seed-vegetable cropping pattern, the farmers who grew oil seed-legume cropping pattern were more likely to adopt crop residues for soil conservation rather than the others two cropping patterns. However, unless

farmers had enough fodder to feed the cattle, they did not want to apply crop residues for soil conservation. They preferred to use their crop residues for animals' fodder.

Among the oil seed crops, the farmers who grew more sesame did not want to apply crop residues for soil conservation. They burnt their sesame crop residues because they were reluctant the spreading of the diseases and pests from year to year through the application of sesame crop residues. As farmers were afraid to spread fungal diseases from the previous crops, especially sesame bacterial wilt, they burnt their sesame crop residues in their fields. Otherwise, they made compost using sesame residues. However, most of the farmers burnt the sesame residues and only a few farmers, especially large scale farmers, made compost by using the sesame residues. They did not make compost by using other crop residues in this area. Groundnut residues, especially stems and leaves, were used for both fodder and soil conservation. Some farmers sold their groundnut shell and some used them for soil conservation as mulching. All cereal crops; namely rice and sorghum were used as fodder. However, some farmers sold their rice straw unless they had cattle and they did not use rice straw for soil conservation.

Farmers rarely grew the green manure crops. They grew cowpea as a green manure in last two years. The name of this variety was Aremelay (local name). This was a new variety and had more vegetative growth than the reproductive growth. Farmers sometimes grew the cowpea for their soil improvement if their soil condition was poor because cowpea, especially its roots, could improve the soil fertility condition. Some farmers intercropped green gram with cowpea. They broadcasted the cowpea seeds when the green gram was at the reproductive growth. They picked up the pods from green gram for two or three times. After harvesting the pods of green

gram, they buried the cowpea together with the green gram stems. At that time, cowpea was at the beginning of reproductive state. They buried the cowpea into the soil at the end of vegetative state or at the beginning of the reproductive state.

According to planting dates, farmers' adoption of soil conservation using crop residues changed. They grew crops two times, monsoon and late monsoon. Most of the monsoon crop residues were buried during the land preparation if their crops were caught by rain. Otherwise, they kept their crop residues for fodder. However, most of the late monsoon crops or winter crops, especially green gram and groundnut residues were kept as animals' fodder. Only a few farmers used crop residues as mulch.

4.9 Estimated amount of production and utilization of crops' biomass

According to Table 4.13, the estimated amount of average biomass production was 3.64 ton / ha. Total biomass productions were used 37.3 per cent for soil conservation, 42.9 per cent for fodder and 19.8 per cent for burning.

Table 4.13 Estimated amount of production and utilization of total biomass

Items	Mean (Ton / ha)	Standard deviation	% of total crop biomass production
Using for soil conservation	1.36	0.90	37.3
Using for Fodder	1.56	0.76	42.9
Burning crop residues	0.72	0.53	19.8
Crop biomass production	3.64	0.17	100

Source: Survey data (2010)

4.10 The problems and constraints to use organic materials for soil conservation

There were three ways of crop residues management: (1) burning them in the field, (2) bringing them home for livestock feed, and using them as an alternative energy source for cooking.

During dry period, as grazing lands was scarce, feed for livestock was scare. Crop residues were extensively used for animal feed (by-products of oil crops, peas, beans, etc). Although sorghum was a typical fodder crops, this was insufficient. So crop residues were traditionally used as animal feed. Draught animals still had to be relied upon in about 85 per cent of all cultivation. Unless the farmers had enough fodder, they seldom used the crop residues for soil conservation and they used for fodder.

Due to lack of fuel wood, the stems of pigeon peas were also burnt for domestic use. Most of the sesame straws were burning because some farmers were reluctant to use this. The main reason was that they did not want to spread the sesame bacterial wilt from season to season. They thought that it was a problem to control the pests and disease if they left crop residues in their fields.

Compost quality was often poor although traditional farm yard manure preparation was common because of lack of sufficient and homogenous breakdown, leaching and loss of nutrients, poor conservation, lack of watering, etc. Farmers could not use compost extensively because of insufficient amount. This was due to livestock ownership, particularly cattle, being very low among the farmers. So some farmers applied compost rotate to their farms. Besides, other limitation for using compost might be labor, time consumption, lack of knowledge making the compost, no space to make this and laborious. Here again the constraint was the available of the manure

in required quantities as well as labor and transportation materials of the manure from point of production to the farms.

The limitation for using green manure might be labor and time consuming and not giving particular good response in terms of yield increments under dry conditions, especially during the first year. So, farmers might be reluctant to use legume produced for manuring purposes instead for animal feed. Farmers might be reluctant to use space for no monetary value crops such as green manure crops.