4. Results

4.1 Historical Background of Ban Yapanae

Ban Yapanae's settlement dated back to some 40 years ago. It was a relatively closed self-subsistence system. The major change in the ecosystem and social system were caused by the inhabitants rather than outside forces. Village life was plain and simple. Natural resources were abundant, and agricultural production and forest production gathering always satisfied the needs of all households. Surplus production could be traded for other foods with nearby villages. Most of the cultivated land was planted to upland rice with homegardens close to the house. The immigration from other areas has been continued until now.

The elders played an important role in the village ways of life. Belief of elders was related to the belief in spirits, which provide effective control over communal behavior. Even the village was named after Mr. Ya Pa Nae, who first settled down in this area about 40 year ago, now he is 63 years old.

4.2 Changes in Availability of Natural Resources

Natural resources are important and related to all agroecosystem charateristics. Since there was population pressure cause to an increase in landuse and the utilization of forest products, almost fertile areas were selected for cultivation. The traditional practice of shifting cultivation system has brought to a break down of the balanced ecological situation. The preservation of natural resources is no longer guaranteed. The forests areas are rapidly reduced and the fallow periods are becoming shorter. Reforestation effort by the Royal Thai government have been to be scattered due to budget limitations and high costs. The continuing migration together with the internal expansion of village population resulting in an early decline of the availability of natural resource, and a further decline in the availability of forest product.

4.3 Socio-economic Environment

4.3.1 The Village Households

Among three villages, Ban Yapanae had the highest number of households and population, 59 and 337, respectively. Members per household of the study area ranged from 3.75 to 5.71 as shown on Table 2.

Table 2 Total households and population of three villages around study area

Village	Household	Man	Woman	Person	Pop/HH.	Sample Size
Phapeuk	28	61	44	105	3.75	12
Yapanae	59	163	174	337	5.71	24
Jabo	35	95	94	189	5.40	14

Farmer respondents aged from 36 to 40 years, with family size of 6.2 to 7.0 (Table 3). Ban Yapanae had largest family size and also largest figures in children and labor force. The average labor force for agriculture ranged from 2.8 to 3.1.

Table 3 Family structure of the study area

Village	Age	Family size	Man	Woman	Children	Labor force
Phapeuk	36.6	6.2	3.6	2.6	2.4	2.8
Yapanae	38.1	7.0	3.5	3.5	3.0	3.1
Jabo	40.2	6.3	3.3	3.0	2.0	3.0

4.3.2 Agricultural Aspect

An average number of plots used for cultivation per household was 2.93 to 3.54. Although Ban Yapanae had the highest figure of population per household, cultivated areas per household of this village were lowest (Table 4). The average year used for cultivation were 3.21 in Phapeuk, 4.92 in Yapanae, and 4.29 in Jabo. In the past land for farming has been abundant, but in present situation the farmers have to face that cultivable land becomes scarcer and in a relatively short fallow period. They used the available land longer than before. The ratio between cultivated and fallowed period in traditional system being about 1:10, has been decreased to an average of 1:1 or even 2:1 (TG-HDP, 1989).

Table 4 Average number of plots, areas and years used for cultivation

Village	No.of plots		Area(rai)		Year cultivated	
	mean	S.D.	mean	S.D.	mean	S.D.
Phapeuk	3.50	1.04	13.46	5.88	3.21	1.84
Yapanae	2.93	1.28	10.54	3.46	4.92	3.55
Jabo	3.54	1.26	10.81	4.92	4.29	3.50

The areas for cultivation of Phapeuk and Yapanae were found to be dominant at the middle slopes followed by the foot and upper slopes. In Jabo village the cultivated area was mostly found at the middle slope (Table 5).

Table 5 Distribution of cultivated plots at different positions along the slope

Village	Slope Position		
	Upper	Middle	Lower
Phapeuk	2	25	14
Yapanae	11	38	21
Jabo	9	36	5

Distribution of the plots used for field crop cultivation at different slope gradient is shown in Table 6. Phapeuk has similar distribution of cultivated areas within three gradient classes. In Yapanae, most of plots were located in medium gradient (21-35 %) while in Jabo the highest number of plots were in medium slope and only 5 plots were located in low slope gradient (0-20 %)

Table 6 Distribution of the cultivated plots in different gradient

Village	Slope gradient		
	high (>35%)	Medium (21-35%)	Low (0-20%)
Phapeuk	12	14	15
Yapanae	15	29	26
Jabo	19	26	5

4.3.3 Upland Rice Cultivation and Management

Average area for upland rice cultivation per household, in 1989, ranged from 4.3 to 5.4 rai as shown on Table 7. The fields were slashed during the dry season, Febuary to March, and allowed to dry until the end of March or early April which the hottest and driest period of the year. Most of the respondents burned residues of preceding crop before planting. Only a few farmers who joined TG-HDP used mulching practices. Tillage was done in the areas where weeds were abundant, by traditional tools such as hoes and spades. In late May, after the fields had been completely cleared of unburned trash, the main crop of rice was planted. Varieties were selected by each household on the basis of taste preferences. Most of the farmers used local variety namely Korma, while high yielding variety of Jaoho being used in the demonstration plots (Table 8). Many other species were also planted, including maize, sorghum, beans, cucurbits, peppers, taro, sweet potato, sunflower, etc.

Table 7 Cultivated area (rai per household) and residue management on upland rice field by farmers

Village	Upland rice area		Residue management		
	mean	S.D.	Burning	Mulching	Both
Phapeuk	4.3	2.9	9	0	3
Yapanae	5.4	2.2	17	0	7
Jabo	5.2	2.4	14	0	0

Table 8 Varieties of upland rice used by farmers in 1989

Village	Jaohor	Korpapor	Korma
Phapeuk	8	2	2
Yapanae	2	0	22
Jabo	6	7	1

Most farmers in Phapeuk and Yapanae weeded their upland rice fields three times while the farmers in Jabo did twice during growing season (Table 9). The average labor needed for maintaining one rai of upland rice is presented on Table 10. Weeding required 22.3 man-day/rai which was the highest among other activities in upland rice production then followed by land preparation and transportation. Threshing demanded the least labor of only 2.3 man-day/rai. No pesticide was applied.

Table 9 Number of farmers who weeded the upland rice field

Village	2 times	3 times
Phapeuk	2	10
Yapanae	1	23
Jabo	12	2

Table 10 Labor required for maintaining one rai of upland rice (man-day)

Village	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	Total
Phapeuk	5	3.0	0	0	22.1	3.2	1.8	4.8	39.9
Yapanae	5	3.1	0	0	27.2	4.3	2.7	5.3	47.6
Jabo	4	3.7	0	0	14.1	3.0	2.1	3.1	30.0
Average	4.7	3.2	0	0	22.3	3.7	2.3	4.8	41.0

Note
(a) = Land preparation (b) = Planting
(c) = Fungicide application (d) = Insecticide application
(e) = Weeding (f) = Harvesting
(g) = Threshing (h) = Transportation

In term of fertilizer application, no farmer used manure (organic fertilizer). Only half of the farmers in Phapeuk and few farmers in other villages used chemical fertilizers as shown on Table 11.

Table 11 Number of farmers who applied fertilizer in upland rice fields

Village	Chemical		Manure	
	Yes	No	Yes	No
Phapeuk	6	6	0	12
Yapanae	2	22	0	24
Jabo	5	9	0	14

The estimated yield of upland rice in 1989 was 186 kg/rai in Phapeuk, 224 kg/rai in Yapanae and 201 kg/rai in Jabo (Table 12). However, 84 % of farmers had insufficient rice for their consumption (Table 13).

Table 12 Average yield of upland rice in 1989

Village	(kg/rai)	S.D.
Phapeuk	140	69.5
Yapanae	224	126.4
Jabo	201	126.7

Table 13 Rice sufficiency for home consumption (household)

Village	Yes	No
Phapeuk	3	9
Yapanae	4	20
Jabo	1	13
Total	8	42

4.3.4 Income

The average gross return of agricultural and other activities in three villages were 5,522 baht (Table 14). The highest expenditure was on clothing and food. The average mamount of saving was 474 baht per household per year.

TABLE 14 Return, expenditure and saving of the households

Village	Total Return(Baht)		Expenditure (baht)					Saving
	Agri.	Other	Agri.	Food	Cloth	Med.	House repairing	
Phapeuk	6033	875	800	1358	1225	200	333	1237
Yapanae	5004	1478	878	1407	1564	489	357	328
Jabo	3651	616	314	1183	1408	333	402	176
Mean	4602	920	589	1288	1408	345	373	474

4.3.5 Experience on Soil Conservation Measures

The farmers' experiences on soil conservation measures is presented on Table 15. Only grass strip recommended by TG-HDP was familiar to all of the farmers while only 4 of them in Yapanae were familiarized with strip cropping. Since the TG-HDP promoted grass strip as soil and water conservation technique (SWC) in 1987, an approximately 30 % of the households applied the SWC pattern on one fifth to half of their farms land (TG-HDP, 1989). Most of farmers observed that their field had serious problems on sheet and rill erosion.

Table 15 Farmers' experience on soil conservation measurers (households)

Village	a	b	c	d	e	f	g	h	i
Phapeuk	12	0	0	0	0	0	0	0	0
Yapanae	24	4	0	0	0	0	0	0	0
Jabo	14	0	0	0	0	0	0	0	0

Note :
a = Grass strip b = Strip cropping c = Contour planting
d = Minimum tillage e = Mulching f = Rock line
g = Contour bank h = Early planting i = Weeding

Traditional practices of most farmers were low input methods. This was restricted by the lack of cash and the difficulties of getting credit. However, all of them needed some soil conservation structures to control it.

4.4 Climatological Data of Maehongson

Climate of Maehongson province can be classified as tropical Savana (Aw) according to Koppen's system (Oldeman and Frere 1982). Rainfall intensity and distribution is influenced by south-west monsoon which prevails from May to October. Climatological data gathered by Maehongson meteorological station from 1973-1982 (Table 16) can be summarized as below.

Mean annual temperature is 25.3 ^{o}C with mean monthly maxima and minima of 38.0 ^{o}C in April and 14.1 ^{o}C in January respectively. Annual rainfall is about 1284 mm and rainy days totaled to 142 days. There were 26 rainy days in August comparing to only 1 rainy day recorded in February. Annual humidity is 74 %, the highest humidity of 84.6 % measured in August while April has the lowest humidity of 52.4 %. Annual evaporation is 719 mm of which 134.1 mm was recorded in April and the lowest was recorded in August of about 32.9 mm.

4.4.1 Start of Growing Season

The start of rain which was estimated by using 20 mm rain within two consecutive days as criteria, according to Stern (1982) was presented by Ekasingh et al. (1988). The median date for the start of rain of Maehongson is 11th May and delayed to 18th May at 80 percentage point.

Table 16 Climatological data of Muang District, Mae Hong Son Province (1978-1982)

Months	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sep.	Oct.	Nov.	Dec	Total
Rainfall (mm)	15.8	1.5	8.7	37.7	179.3	174.9	224.3	265.3	219.3	106.3	33.9	15.4	1282.4
Mean riany days	2.0	1.0	2.0	5.0	17.0	22.0	25.0	26.0	21.0	14.0	5.0	3.0	143.0
Mean maximum temp.(c°)	29.1	32.7	36.3	38.0	34.8	32.4	31.4	31.1	31.8	32.4	30.9	28.9	-
Mean minimum temp.(c°)	14.1	14.4	15.2	22.7	23.9	23.9	21.5	23.0	23.0	21.8	19.3	15.4	-
Mean temp. (c°)	20.0	22.1	26.0	29.9	28.4	27.2	26.6	26.3	26.4	25.9	23.9	20.8	-
Evaporation (mm)	47.4	69.5	110.0	134.1	81.2	46.7	39.2	32.9	35.0	38.6	37.3	39.6	711.5
Relative humidity (%)	75.5	66.2	53.6	52.4	70.9	79.1	82.3	84.6	84.3	81.9	79.6	78.1	-

Source : Synoptic station of Muang District, Mae Hong Son Province.

4.4.2 End of Growing Season

The end of growing season depends on the available water capacity (AWC) of the soil. The median end of growing season of Maehongson is 24^{th} November for the soil which has AWC 100 mm and extend to 11^{th} January for 200 mm AWC (Ekasingh et al. 1988).

4.4.3 Potential Growing Season

Potential growing season can be considered as the period between the start of rain and the end of growing season. The mean period of growing season for Mae Hong Son station with AWC of 100 mm is 200 ± 21 days while growing season extends to 249 ± 19 days for area with AWC of 200 mm.

4.5 Climatic Data at the Experimental Site

4.5.1 Rainfall

In 1989, rainy season commenced early on May 6^{th}, and ended on the 18^{th} of October. Rainfall of 1515.2 mm was recorded at the experimental site and 1433.8 mm at the TG-HDP meteorological station. Weekly rainfall from March to October is presented in Figure 3. There was a short dry spell during the last week of June, after that rainfall was well distributed until mid-October.

4.5.2 Rainfall Intensities

There were 36 storms of rainfall exceeding 12.5 mm as shown Table 17, of which 15 storms exceeded 25 mm. Three significant storms were recorded. Firstly, on July 11th, 50 mm of rain within 2 hours was recorded. Secondly, on August 16th, 40 mm of rain lasted for 84 minutes was recorded. The third storm was on September 23th with 25 mm in 23 minutes. Total erosivity index (R-subfactor) was 671.1 m-T/ha/yr of which 27.2 % occurred within May. Weekly erosivity index(EI_{30}) is shown in Figure 3.

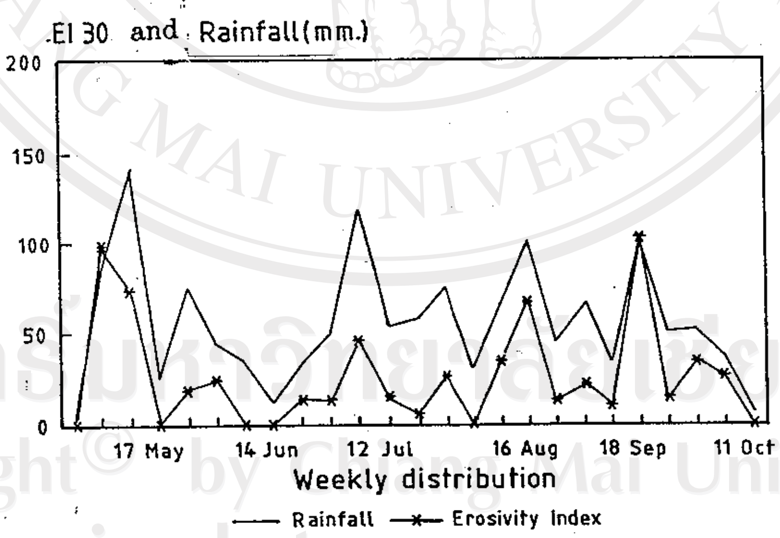

Figure 3 Rainfall and erosivity index at Pangmapha District, Maehongson Province (1989)

Table 17 Rainfall amount and erosivity index of Jabo station in 1989, Pangmapha District, Maehongson Province

Date		Rainfall (mm)	Intensity (cm/hr)	Total-KE t-m/ha	Erosivity Index	Cumulative Erosivity Index
May	8	50.3	na	na	40.4	40.4
May	11	18.5	na	na	10.5	50.9
May	12	15.5	na	na	7.7	58.5
May	13	50.0	na	na	40.1	98.6
May	14	69.0	na	na	58.0	156.6
May	16	13.6	na	na	5.9	162.5
May	20	17.0	2.2	414.2	9.2	171.7
May	28	28.8	0.9	535.7	5.0	176.7
May	29	16.6	1.7	345.4	6.0	182.7
Jun	2	22.0	1.8	477.4	8.6	191.3
Jun	8	31.0	3.3	754.2	24.9	216.2
Jun	29	31.0	2.0	711.2	14.7	230.9
Jul	6	21.0	2.8	507.2	14.5	245.3
Jul	11	58.7	2.2	1353.7	30.3	275.7
Jul	13	30.0	1.5	669.0	10.6	286.2
Jul	14	13.0	2.0	270.2	5.4	291.6
Jul	18	23.0	3.0	545.9	16.4	308.0
Jul	25	21.0	1.9	350.8	6.7	314.7
Jul	30	22.0	2.5	467.7	12.0	326.6
Jul	31	20.0	0.6	346.8	2.2	328.8
Aug	5	24.0	2.5	517.0	13.4	342.2
Aug	14	17.0	1.8	303.3	5.5	347.7
Aug	16	43.0	2.8	1042.2	29.8	377.5
Aug	21	15.0	1.8	349.0	6.3	383.8
Aug	24	20.0	2.1	422.0	8.9	392.7
Aug	25	35.0	6.1	856.4	52.7	445.4
Aug	28	16.0	2.6	326.3	8.6	453.9
Aug	30	14.5	1.4	301.0	4.3	458.3
Sep	7	21.0	2.0	495.2	9.9	468.2
Sep	8	30.0	2.0	637.5	12.8	481.0
Sep	15	16.0	2.8	389.9	10.9	491.9
Sep	22	34.0	4.1	796.8	32.8	524.7
Sep	23	44.5	6.5	1070.2	69.8	594.5
Sep	29	35.5	1.8	827.7	15.1	609.5
Oct	1	16.7	8.0	439.5	35.3	644.8
Oct	2	25.5	4.5	585.4	26.3	671.1

na = not available

4.6 The Soil of the Experimental Area

The soil is classified as clayey, Kaolinitic, isohyperthermic, Oxic Paleustult. It is characterized by a dark reddish brown clay or silty clay A-horizon overlying dark reddish brown or reddish brown clay upper argillic B horizon which in turn overlies red or dark red clay lower argillic B horizon. Soil reaction is slightly acid to strongly acid. The fertility of soil is medium with 2.4 % of organic matter, 24 me/100g of CEC, 9.25 ppm of P and high level of K (230 ppm). Bulk density of the soil is 1.09 g/cm^3, as shown in Table 18.

Table 18 Soil analysis from upland rice fields

Depth (cm)	pH	CEC me/100g	O.M. %	P ppm	K ppm	Texture	B.D. (g/cc)
<u>(a) Experimental fields</u>							
0 - 5	5.6	37.8	5.0	34.5	551.5	Clay-Loam	1.10
5 - 20	5.4	34.1	3.2	9.5	170.5	Clay	1.10
20 - 40	5.6	19.7	2.1	3.5	137.0	Clay	1.20
40 - 60	5.7	16.1	2.0	2.5	103.7	Clay	1.22
60 - 80	5.1	20.8	1.3	3.5	196.2	Clay	1.19
> 80	5.3	15.2	0.6	2.0	251.2	Clay	1.18
<u>(b) Observed fields</u>							
0 - 5	5.5	21.3	2.9	12.0	238.7	Scl *	1.30
5 - 20	5.0	20.2	2.7	3.0	112.7	Clay	1.30
20 - 40	5.1	25.3	3.4	3.0	133.2	Clay	1.33
40 - 60	5.1	18.4	1.8	2.0	73.2	Clay	1.34
60 - 80	5.1	16.4	1.9	2.0	108.7	Clay	1.38
> 80	5.2	30.1	1.5	5.5	126.7	Clay	1.37

* = Sandy Clay Loam

4.7 Distribution of Crop Residue

The conservation cropping system recommended by the TG-HDP was grass strip cropping. Under this recommendation, approximately half of the farmers' fields were allocated to upland rice in every second strip. The alternative strips were used for sequential croppings of either corn/blackbean, corn/redbean or corn/lablab.

On the experimental site, during the preceding year, about half of the land was upland rice while the rest of the land were sequential croppings of corn/red kidney bean and corn/lablab. An average dry matter of residue prior to investigation period is shown in Table 19. The highest dry matter of the residue remaining on the surface at the time of planting of rice in this study was 2.23 t/ha from the plot where upland rice was planted earlier. Residue from sequential cropping of corn/lablab was 1.87 t/ha while corn/red kidney bean gave the same level of residue of 1.85 t/ha.

Table 19 Dry matter of residue before planting (t/ha)

Treatments	Planting date			
	Early	S.D.	Regular	S.D.
No Mulch	0		0	
Upland Rice Mulch	2.14	0.64	2.33	0.81
Corn-Laplap Mulch	1.79	0.23	1.95	0.28
Corn-Red Kidney bean	1.87	0.55	1.82	0.23

4.8 Ground Cover Percentage

An average ground cover from residue mulching was 72% at the time of rice planting but dropped dramatically in the third week. The reduction of crop residue was due partly by transportation of residue by runoff water and partly by decaying. Three months after rice planting, no more residue of the previous crop was observed on the ground. Only residue of weeds and senesced leaves of upland rice contributed to the ground cover during this period. The cover percentage by the different residues are presented in Figure 4.

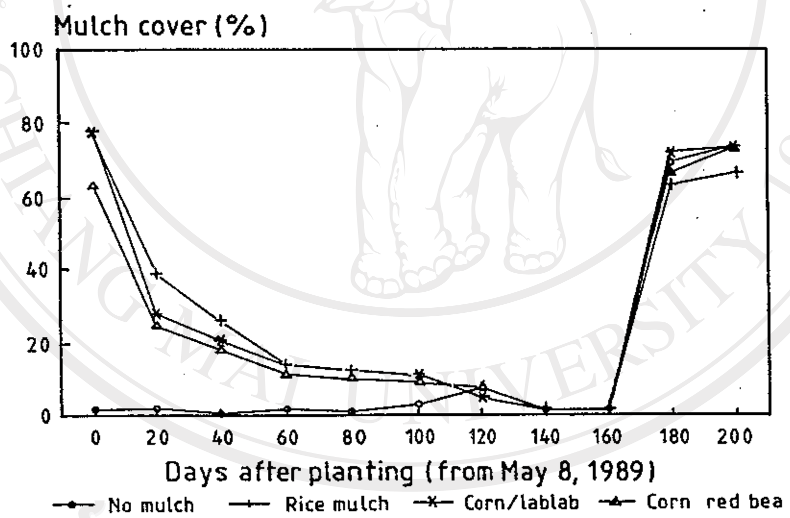

Figure 4 Mulch cover percentage throughout growing season (1989)

Vegetative cover was affected by canopy of upland rice and weeds. The canopy of weeds had more effectiveness than that of upland rice during the beginning of growing season. The plots mulched with the residue of corn/lablab and corn/red kidney bean had higher ground cover due to the volunteer seedling of lablab and red kidney bean. After two months, the surface cover was contributed mainly by upland rice canopy. At 100 days after sowing, more than 80 % of ground were covered by rice canopy. An average ground cover by crop canopy are presented in Figure 5 and 6.

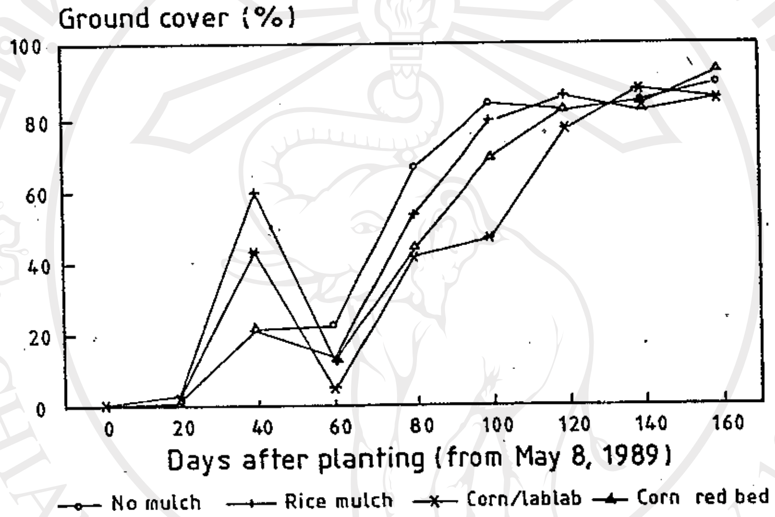

Figure 5 Canopy cover percentage from early planting (1989)

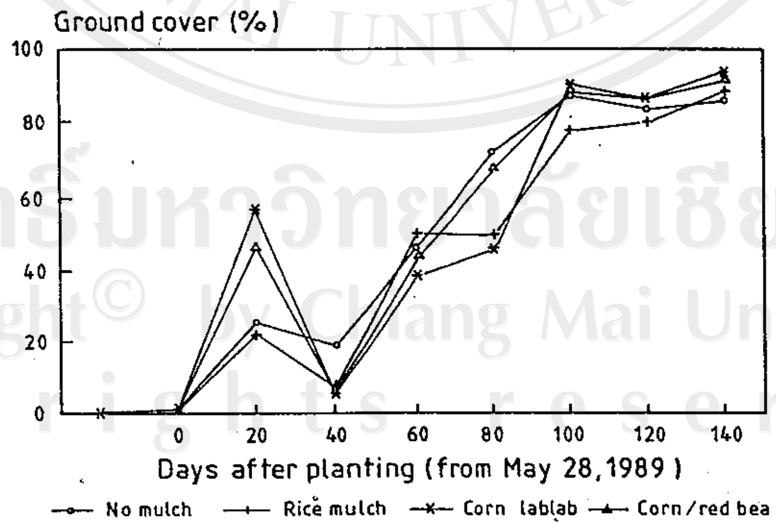

Figure 6 Canopy cover percentage from regular planting (1989)

Total ground cover percentage as the result of residue and crop canopy is presented in Figure 7. Plant canopy is the important indicator of effectiveness in agronomic conservation. Canopy of living plants protects the soil from rainsplash and their roots help holding soil particles against dislodging. Residue mulching performs similar functions by protecting the soil from raindrop impacts and facilitating water infiltration.

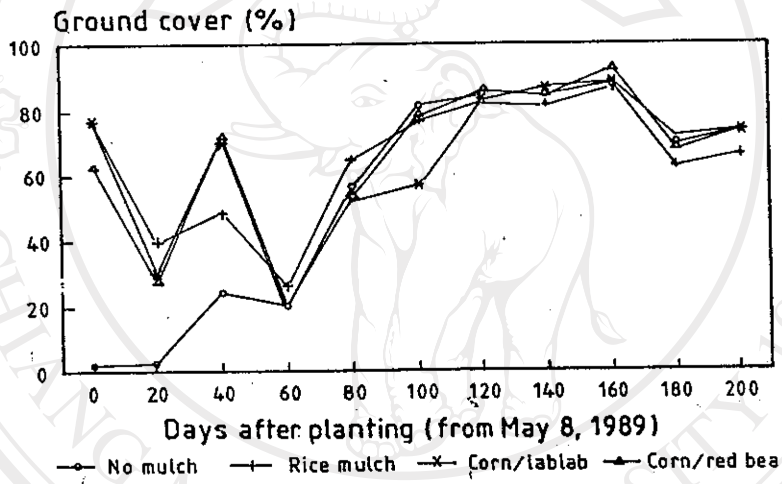

Figure 7 Total ground cover percentage throughout growing season (1989)

4.9 Cropping Factor (C-value)

The cropping factor(C-value) indicates the effectiveness of plant canopy and mulch in erosion reduction. Low value of "C" represents condition of lower erosion if other variables in USLE are held constant. As shown in Table 20, "C" value for early planting was 0.42 comparing to 0.41 in regular planting.

The "C" value from condition of no mulching was 0.54 comparing with 0.38 for mulch with residue of previous crops. An average value from the field of traditional cultivation in upland rice was 0.66. The distribution of C-values during growing season among mulching, no-mulching and observed field are presented on Figure 8.

Table 20 Estimated C-subfactor for using in USLE model

Treatments	Planting Date			
	Early		Regular	
	Mean	S.D.	Mean	S.D.
None	0.55	0.07	0.52	0.07
Rice-Mulch	0.38	0.03	0.34	0.03
C/LL-Mulch	0.39	0.04	0.37	0.04
C/RB-Mulch	0.41	0.04	0.40	0.04
Mean	0.42		0.41	

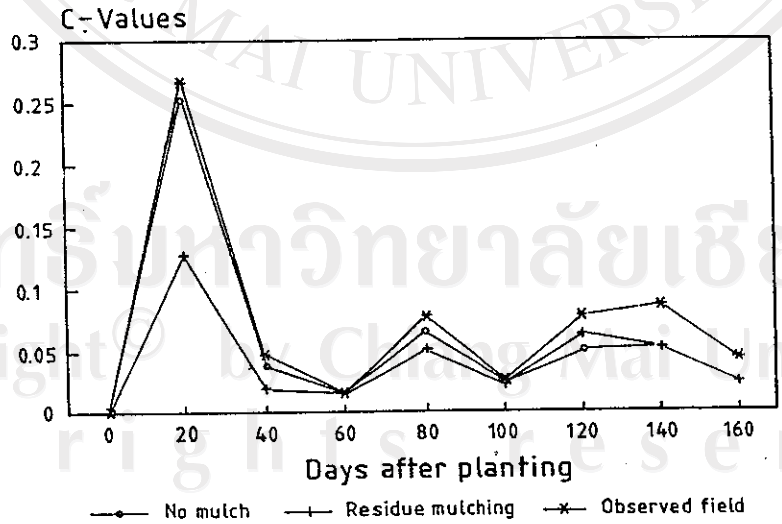

Figure 8 Cropping factor in upland rice field

The C-values in each crop stage periods as defined by Wischmeier and Smith (1978) are presented on Table 21. For each crop stage period the erosivity value, mulch subfactor and canopy subfactor are multiplied to the yield of the C-value. The period F (rough fallow) has no rain, therefore the C-value in this period was zero. The highest C-value was found on period SB, from planting to 10 % of canopy cover, particularly on no-mulched treatment which was double of mulch plots. After that, the C-values among treatments were slightly different, due to the increase in surface ground cover by crop canopy. The highest C-valve was 0.54 from no-mulching, while 0.36, 0.38 and 0.40 were obtained from mulching with residue of upland rice, corn/lablab and corn/red kidney bean, respectively. Therefore, good ground cover in the beginning of rainy season is very important factor that reduces C-value in USLE.

Table 21 The C-value for each upland rice crop stages on different residue management

	None	Rice-mul	C/LL-mul	C/RB-mul
Period F	0.00	0.00	0.00	0.00
Period SB	0.31	0.14	0.17	0.18
Period 1	0.06	0.04	0.04	0.05
Period 2	0.04	0.04	0.04	0.04
Period 3	0.13	0.14	0.13	0.13
Total	0.54	0.36	0.38	0.40

Note :
Period F (Rough fallow) Before planting (Apr to May 8)
Period SB From planting to 10 % canopy cover (May 8 to Jul 5)
Period 1 (Establishment) From 10 to 50 % cover(Jul 5 - Jul 27)
Period 2 (Development) From 50 to 75 % cover (Jul 27 to Sep 8)
Period 3 (Maturing) From 75 % to harvesting (Sep 8 to Oct 17)

4.10 Yield of Upland Rice

The yield of upland rice on different planting dates and residue management were not significantly different. An average yield was 2.2 t/ha from the experimental plots comparing to 2.0 t/ha from the observed fields (Table 22 and 23).

Table 22 Yield of upland rice (t/ha) from the experimental plots

Treatments	Planting Date			
	Early		Regular	
	Mean	S.D.	Mean	S.D.
None	1.89	0.70	2.80	0.35
Rice-Mulch	1.88	1.00	1.81	0.62
C/LL-Mulch	2.04	0.75	2.44	0.53
C/RB-Mulch	2.49	0.29	2.40	0.86
Mean	2.08		2.36	

Table 23 Yield of upland rice (t/ha) from the observed fields

Farmer	Rice Yield	Total dry matter	Harvest Index
1	0.64	1.36	0.47
2	1.52	2.98	0.51
3	3.20	7.40	0.43
4	2.80	5.90	0.47
5	1.04	2.38	0.44
6	1.92	3.88	0.49
7	3.76	7.65	0.49
8	2.80	6.22	0.45
9	2.48	5.91	0.42
10	0.64	1.37	0.47
11	0.88	2.01	0.44
12	2.16	4.33	0.50
Average	2.00	4.28	0.46

The upland rice was damaged by white glub which attacked the plants three weeks after germination, particularly in the plots mulched with residue of upland rice and corn/lablab. The residue of corn/lablab and upland rice might be a good host for the white glub. Therefore, the yield from the plots mulched by these materials tended to be lower than the others.

Total dry matter of upland rice, including dry matter of straw and grain yield are presented on Table 23 and 24. No significant differences among treatments were observed. An average total dry matter was about 5.2 t/ha from experimental plots and 4.28 t/ha from the observed fields. The average harvest index of upland rice was about 0.43.

Table 24 Total dry matter of upland rice in different treatments (t/ha)

Treatments	Planting Date				Harvest Index
	Early		Regular		
	Mean	S.D.	Mean	S.D.	
None	4.69	1.45	6.64	0.80	0.41
Rice-Mulch	4.54	2.62	4.27	1.56	0.42
C/LL-Mulch	4.54	1.86	5.30	1.21	0.46
C/RB-Mulch	5.72	1.09	5.67	2.27	0.43
Mean	4.78		5.47		0.43

4.11 Top Soil Movement

Top soil movement was measured by staking technique in order to monitor top soil loss (Table 25). It shows significant differences among the crop residue management practices but not on planting dates. Mulching with residues of upland rice and corn/lablab significantly reduced soil loss by 50 %, comparing to no mulch or mulch with residues of corn/red kidney bean. However, the top soil loss from mulching with residue of corn/red kidney bean was not significantly different from the no mulch treatment. The average soil loss from mulching condition was 111 t/ha while the average soil loss from the no-mulch plot was 165 t/ha. Therefore, an agronomic practice using residues for mulching would reduce soil loss by 33 percent.

Table 25 Top soil loss (t/ha) measured by staking technique in the experimental fields

Treatments	Planting Date		Mean
	Early	Regular	
None	169.90	159.70	164.80
Rice-Mulch	86.60	79.60	83.10
C/LL-Mulch	107.80	46.30	77.05
C/RB-Mulch	108.60	158.70	172.16
Mean	137.48	111.70	124.28

LSD for planting date = ± 43.1 t/ha
0.05 for mulching = ± 77.6 t/ha

Soil loss was also estimated by modeling of Universal Soil Loss Equation (USLE). The R-subfactor obtained by using from TG-HDP meteorological station was 671.1 m-T/ha. The K-subfactor for the clayey soil of experimental plots and observed plots was 0.20.

The slope length of the plots, cultivated as contour grass strip was taken as the distance between the grass strip because velocity of runoff was dramatically retarded by the growth of closely grown grass. The steepness of slope was also measured from each plots with an average of 46.3 percent. The slope gradient and length of slope on the strips which were mulched with residue of corn/red kidney bean was significantly higher than other strips resulted in higher value of the LS-subfactor, the composite number representing the effect of slope length and steepness. The LS-values of experimental plots are presented on Table 26.

Table 26 Estimated LS-factor of experimental plots

Treatments	Planting Date		Mean
	Early	Regular	
None	4.47	4.37	4.42
Rice-Mulch	4.55	4.57	4.56
C/LL-Mulch	4.53	4.38	4.46
C/RB-Mulch	5.01	5.23	5.12
Mean	4.64	4.64	4.64

$LSD_{0.05}$ for planting date = ± 0.21
for mulching = ± 0.35

The C-value for different treatments were presented in Table 20. The P-subfactor was mentioned earlier that for conservation of contour grass strip and strip cropping, P-value was computed as 0.85 and for observed upland rice fields the value of 1.0 was used.

The rates of top soil loss calculated by the model for the experimental plots are presented in Table 27. The highest rate of top soil loss was 272.3 t/ha or equivalent to 2.27 cm from treatment with no mulching which was significantly higher than other treatments. Soil loss of 234.1 t/ha or 1.95 cm was found in the plots mulched with residue of corn/red kidney bean. The lowest soil loss was 187.2 t/ha or 1.56 cm recorded from the plots mulched with residue of upland rice and the soil loss of 193.4 t/ha or 1.61 cm was recorded from plots mulched with residue of corn/lablab.

Table 27 Average soil loss from different treatments estimated by USLE model

	R (m-t/ha/yr)	K (t/m-t)	LS	C	P	Soil loss (t/ha/yr)
None	671.1	0.2	4.42	0.54	0.85	272.3
Rice-Mulch	671.1	0.2	4.56	0.36	0.85	187.2
C/LL-Mulch	671.1	0.2	4.46	0.38	0.85	193.4
C/RB-Mulch	671.1	0.2	5.12	0.40	0.85	234.1
Average	671.1	0.2	4.64	0.42	0.85	

$LSD_{0.05}$ for soil loss = ± 18.6 t/ha.

In twelve farmers fields where crop cover and top soil loss were monitored, the slope gradient ranged from 12 to 43 % (Table 28). The length of slope from top of the hill to the representative areas was ranged from 20 to 93 meters resulting in estimated LS of 1.51 to 14.0. The C-value obtained from onsite measurement varied from 0.54 to 0.82. The C-values are relatively high comparing to those in the experimental plots due to the exposure of the soil surface after the farmers had harvested early rice varieties and wider rice spacing. The estimated soil loss varied from 129.6 to 1221.3 t/ha, with an average of 575.9 t/ha or about 4.30 cm equivalent.

Table 28 Top soil loss from observed fields

Farm No.	Slope %	Length of Slope(m)	LS Factor	C Factor	USLE Soil loss (t/ha)	Equivalent Soil loss (cm/yr)
1	13.4	29.5	2.03	0.71	193.1	1.44
2	34.9	67.7	9.54	0.70	896.1	6.69
3	41.7	22.7	6.71	0.56	504.1	3.76
4	12.2	21.0	1.51	0.64	129.6	0.97
5	42.9	93.0	14.00	0.65	1221.3	9.11
6	28.8	63.0	7.43	0.82	817.8	6.10
7	39.0	39.2	8.20	0.64	704.0	5.25
8	22.6	53.0	5.16	0.54	374.3	2.79
9	19.5	42.8	3.90	0.62	324.5	2.42
10	36.9	20.4	5.57	0.64	478.1	3.57
11	38.5	33.8	7.50	0.67	674.8	5.04
12	34.1	29.5	6.14	0.72	393.1	4.43
Average	30.38	42.97	6.47	0.66	575.9	4.30