APPENDIX

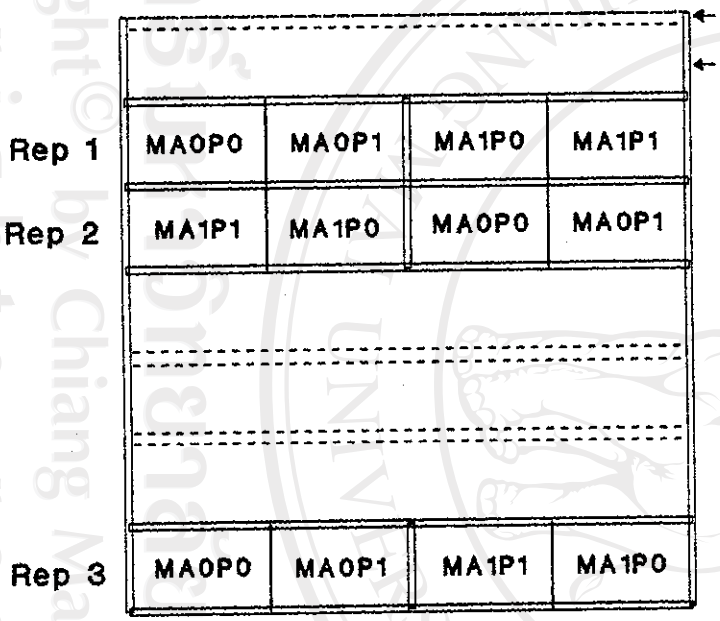
Appendix A

Table A. Rainfall data in 1990 comparing with the 20 years average rainfall (1971-1990) of Mae Rim district, Chiang Mai

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	0	2.93	0	2.83	0	7.16	0
2	-	-	-	-	-	0	0	0	0	0	0	0
3	-	-	-	-	-	0	0	0	0	0	0	0
4	-	-	-	-	-	0	0	13.68	0	0	0	0
5	-	-	-	-	-	0	31.82	0	0	0	11.14	0
6	-	-	-	-	-	0	2.93	0	0	0	0	0
7	-	-	-	-	-	0	0	0	12.73	9.55	22.21	0
8	-	-	-	-	-	0	0	0	0	31.82	25.45	0
9	-	-	-	-	-	0	0	35.00	22.27	0	0	0
10	-	-	-	-	-	0	0	0	0	0	38.18	0
11	-	-	-	-	-	14.16	0	0	19.09	0	0	0
12	-	-	-	-	-	7.16	0	0	0	0	0	0
13	-	-	-	-	-	16.39	0	25.45	19.09	12.73	0	0
14	-	-	-	-	-	0	12.03	0	35.00	0	0	0
15	-	-	-	-	-	0	0	12.73	0	0	0	0
16	-	-	-	-	-	0	8.27	0	50.91	0	0	0
17	-	-	-	-	-	0	0	0	0	0	0	0
18	-	-	-	-	-	0	0	0	0	0	0	0
19	-	-	-	-	-	0	0	0	0	0	0	0
20	-	-	-	-	-	7.48	0	0	0	0	0	0
21	-	-	-	-	-	0	6.36	0	0	25.45	0	0
22	-	-	-	-	-	0	27.84	0	0	31.82	0	0
23	-	-	-	-	-	28.95	0	0	0	0	0	0
24	-	-	-	-	-	1.24	0	0	0	0	0	0
25	-	-	-	-	-	2.96	0	0	0	0	0	0
26	-	-	-	-	-	3.71	0	0	0	0	0	0
27	-	-	-	-	-	1.32	37.70	9.55	0	0	0	0
28	-	-	-	-	-	2.96	0	0	0.35	0	0	0
29	-	-	-	-	-	0	0	0	0.03	0	0	0
30	-	-	-	-	-	0	1.59	98.64	19.09	0	0	0
31	-	-	-	-	-	0	1.59	23.86	0	0	0	0
Total	-	-	-	-	-	86.32	133.06	218.91	181.40	111.36	104.14	0.00
Day	-	-	-	-	-	10	10	7	9	5	5	0
Max.	-	-	-	-	-	28.95	37.70	98.64	50.91	31.82	38.18	0.00
Min.	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg.20 yr.	7.33	0.62	7.55	41.10	135.65	125.81	159.97	180.48	194.96	95.03	45.26	16.66
Deviation	-	-	-	-	-	39.48	26.91	-38.42	13.56	-16.34	-58.88	16.66

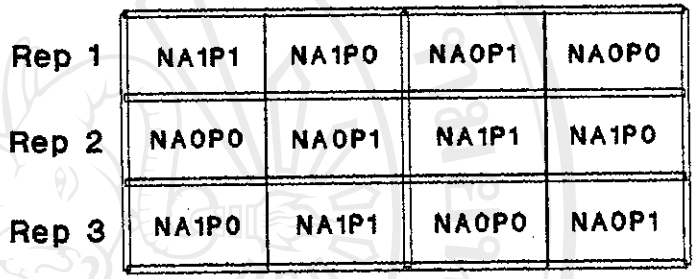
Appendix B Plot lay out

Appendix B-1 The lay out of peanut experiment field (split plot design)



Expt.I (alley plot)

Note : MA0 = non-mulching
MA1 = mulching
P0 = no phosphate
P1 = phosphate
Plot size = 10-30 m^2
Total area = 210 m^2



Expt.II (non-alley plot)

Note : NA0 = non-mulching
NA1 = mulching
P0 = no phosphate
P1 = phosphate
Plot size = 8-16 m^2
Total area = 144 m^2

Appendix B-2 The lay out of soybean experiment field (randomize complete block design)

Rep 1	T3	T1	T2	T0
Rep 2	T2	T0	T1	T3
Rep 3	T0	T3	T2	T1
Rep 4	T3	T1	T2	T0
Rep 5	T1	T2	T0	T3

Expt.I (alley plot)

Rep 1	T0	T1	T2	T3
Rep 2	T0	T2	T1	T3
Rep 3	T0	T2	T1	T3
Rep 4	T3	T1	T2	T0
Rep 5	T0	T2	T1	T3

Expt.II (non-alley plot)

Note • T0 • control
T1 • 0-46-0
T2 • 16-20-0
T3 • 12-24-12
Plot size • 7-17 m^2 (alley) , 4-12 m^2 (non-alley)
Total area • 243 m^2 (alley) , 150 m^2 (non-alley)

Appendix C Analysis of variance of peanut crop

Appendix C-1 Analysis over site

The procedure for combining data analysis over two experiment sites are shown below for a trial involving mulching as main plot and application of phosphate fertilizer as sub plot in a split plot design. The result of individual analysis of variance at each site is based on kernel yield data. The procedure for combining data is as follows:

Apply the chi-square test for homogeneity of variance to the 2 error variances of main plot and sub plot from the individual analysis of variance. If the test is significant, all site whose coefficients of variation are extremely large (i.e., CV > 20%) can be excluded from the combine analysis.

Test for homogeneity of variance

This test is used to verity homogeneity of error variances in combining data from a series of experiments. In order to combine the data from two experiment sites, homogeneity of variance from the two individual split plot analysis of variance must be established. The data collected are kernel yield in kg/ha, and the two error mean squares of main plot and sub plot, each with 2 degrees of freedom and 4 degrees of freedom respectively are:

	Main plot	Sub plot
S^2_1	95218	6811.9
S^2_2	159600	45207

The step by step procedure to apply the chi-squre test to test for homogeneity of variances with equal degree of freedom are:

I Error mean square of main plot

STEP 1. For each variance estimate s^2 , compute log s^2 , where log refers to logarithm base 10. THen, compute the totals of 2 values of s^2 and of log s^2 .

The values of s^2 , and log s^2 , for each of the 2 error mean squared and their totals are shown below:

Site	s^2	log s^2
Alley	95218	4.9787
Non-alley	159600	5.2030
Total	254818	10.1817

STEP 2. Compute the pooled estimate of variance as:

$$s^2_p = \frac{\sum_{i=1}^{2} S_i^2}{2} = 254818/2 = 127409$$

STEP 3. Let f be the degree of freedom of each s_i, k be the number of variance with equal degree of freedom, compute the X^2 value as:

$$X^2 = \frac{(2.0326)\ (f)\ [(k)(\log s_p^2)-(\log s_i^2)]}{1 + [(k+1)/3kf]}$$

For the experiment, the X^2 value is computed as:

$$X^2 = \frac{(2.3026)(2)\ [(2)(\log 127409) - 10.1817]}{1 + [(2+1)/(3)(2)(2)]}$$

$$= \frac{0.1322}{1.25}$$

$$= 0.1057$$

STEP 4. Compare the computed X^2 value with the tabular X^2 value with (k-1) d.f.; and reject the hypothesis of homogeneous variance if the computed X^2 value exceeds the corresponding tabular X^2 value at the prescribed level of significance.

For the experiment, the compute X^2 value is smaller than the corresponding tabular X^2 value with (k-1) = 2-1 = 1 d.f. and at the 5% level of significance 3.84. Thus, the hypothesis that the 2 error variances are homogeneous can not be rejected.

II Error mean square of sub plot

STEP 1.

Site	s^2	log s^2
Alley	6811.9	3.8332
Non-alley	45207	4.6552
Total	52018.9	8.4884

STEP 2. $s^2_p = \frac{52018.2}{2} = 26009.45$

STEP 3. $X^2 = \frac{(2.3026)(4)\,[(2)(\log 26009.45)-(8.4884)]}{1+[(2+1)/(3)(2)(4)]}$

$= \frac{3.1481}{2} = 2.798$

STEP 4. For the experiment, the compute X^2 value is smaller than the corresponding tabular X^2 value with (k-1) = 2-1 = 1 d.f. and at the 5% level of significance 3.84. Thus, the hypothesis that the 2 error variances are homogeneous can not be rejected.

Table C-2 Combined analysis of variance of peanut kernel yield in the alley and the non-alley plot.

Source of variation	DF	MS	P
Site (A)	1	239820	0.305
Rep. with in site (B)			
A*B	4	106520	
Mulching (C)	1	13829	0.758
A*C	1	848	0.938
A*B*C	4	127410	
Phosphate (D)	1	419520	0.004
A*D	1	183140	0.029
C*D	1	20493	0.401
A*C*D	1	11202	0.530
A*B*C*D	8	26009	

Table C-3 Combined analysis of variance of peanut yield component in the alley and the non-alley plot.

Source of variation	DF	Yield components							
		100 seed wt.(g)		Seed/m^2		Pod/m^2		% Shelling	
		MS	P	MS	P	MS	P	MS	P
Site (A)	1	9.97	0.61	34051.00	0.10	5735.00	0.17	75.08	0.31
Rep. with in site (B)									
A*B	4	133.36		7295.70		2034.90		56.52	
Mulching (C)	1	19.10	0.52	504.17	0.83	782.04	0.70	9.92	0.32
A*C	1	9.29	0.65	450.67	0.84	77.04	0.90	14.25	0.24
A*B*C	4	156.05		9786.00		4447.70		7.54	
Phosphate (D)	1	32.50	0.32	26667.00	0.01	7668.40	0.01	14.99	0.21
A*D	1	76.29	0.14	8437.50	0.10	3151.00	0.08	11.33	0.27
C*D	1	69.53	0.16	10.67	0.95	126.04	0.70	9.89	0.31
A*C*D	1	17.70	0.46	368.17	0.71	513.37	0.44	0.86	0.76
A*B*C*D	8	230.46		2411.90		769.21		8024.00	

Table C-4 Combined analysis of variance of peanut dry matter yield in the alley and the non-alley plot

	DF	MS	P
Site (A)	1	644390	0.683
Rep. with in site (B)			
A*B	4	218590	
Mulching (C)	1	18570	0.810
A*C	1	128800	0.051
A*B*C	4	280990	
Phosphate (D)	1	2559	0.969
A*D	1	293310	0.675
C*D	1	2669700	0.226
A*C*D	1	1859500	0.306
A*B*C*D	8	1552500	

Appendix D Analysis of variance of soybean

Table D-1 ANOVA of soybean yield and yield components in different fertilizer treatment in the alley and the non-alley plot.

Source of variation	DF	Yield (kg/ha)		Plant/m^2		Pod/plant		Seed/pod		100 seed wt.(g)	
		MS	P	MS	P	MS	P	MS	P	MS	P
Alley											
Replication (A)	4	30702	0.46	11.50	0.03	2.75	0.626	0.20	0.159	0.62	0.064
Fertilizer (B)	3	206950	0.01	1.60	0.89	31.87	0.003	0.18	0.194	2.32	0.001
A*B	12	31618		8.00		4.12		0.10		0.21	
Non-alley											
Replication (A)	4	666340	0.05	1286.50	0.0002	34.45	0.069	0.01	0.4449	0.89	0.054
Fertilizer (B)	3	717290	0.05	16.18	0.9141	105.67	0.002	0.80	0.0002	1.14	0.033
A*B	12	204050		94.77		11.92		0.01		0.28	

Table D-2 ANOVA of soybean dry matter yield and plant height in different fertilizer treatment in the alley and the non-alley plot

Source of variation	R2			R5				R8						Plant height (cm.)	
					Stem		Pod			Stem		Seed			
	DF	MS	P	DF	MS	P	MS	P	DF	MS	P	MS	P	MS	P
Alley															
Replication (A)	3	22759	0.3159	3	234170	0.478	25026	0.317	4	60712	0.520	30702	0.459	21.73	0.127
Fertilizer (B)	3	410990	0.0001	3	1114200	0.039	115300	0.014	3	843300	0.001	206950	0.007	57.66	0.010
A*B	9	16735		9	259750		18475		12	71850		31618		9.75	
Non-alley															
Replication (A)	2	335350	0.0018	2	106860	0.507	12805	0.372	4	776320	0.015	666340	0.050	47.24	0.002
Fertilizer (B)	3	18795	0.3794	3	647750	0.053	9178	0.520	3	1056300	0.007	717290	0.049	62.47	0.001
A*B	6	15345		6	140050		10937		12	161180		204050		6.02	

Table D-3 ANOVA of nitrogen content in soybean in different fertilizer treatment in the alley and the non-alley plot

Source of variation	Nitrogen content (%)													
				R5					R8					
	R2			Stem			Pod		Stem			Seed		
	DF	MS	P	DF	MS	P	MS	P	DF	MS	P	MS	P	
Alley														
Replication (A)	3	0.002	0.995	3	0.003	0.967	0.002	0.969	4	0.002	0.473	0.031	0.695	
Fertilizer (B)	3	0.014	0.283	3	0.075	0.128	0.052	0.225	3	0.002	0.491	0.073	0.939	
A*B	9	0.093		9	0.030		0.029		12	0.003		0.055		
Non-alley														
Replication (A)	2	0.138	0.307	2	0.102	0.400	0.025	0.532	4	0.032	0.009	0.043	0.275	
Fertilizer (B)	3	1.331	0.004	3	0.055	0.648	0.053	0.309	3	0.019	0.059	0.035	0.324	
A*B	6	0.095		6	0.095		0.036		12	0.006		0.028		

Table D-4 ANOVA of phosphorus content in soybean in different fertilizer treatments in the alley and the non-alley plots.

Source of variation	Phosphorus content (%)													
				R5					R8					
	R2			Stem			Pod		Stem			Seed		
	DF	MS	P	DF	MS	P	MS	P	DF	MS	P	MS	P	
Alley														
Replication (A)	3	0.0003	0.749	3	0.0010	0.773	0.0014	0.581	4	0.00006	0.063	0.0041	0.2417	
Fertilizer (B)	3	0.0224	0.000	3	0.0137	0.021	0.0118	0.016	3	0.00006	0.059	0.0034	0.3111	
A*B	9	0.0006		9	0.0025		0.0020		12	0.00002		0.0026		
Non-alley														
Replication (A)	2	0.0007	0.681	2	0.0003	0.714	0.0001	0.918	4	0.00173	0.001	0.0039	0.0563	
Fertilizer (B)	3	0.0185	0.007	3	0.0119	0.003	0.0177	0.004	3	0.00062	0.044	0.0224	0.0001	
A*B	6	0.0016		6	0.0007		0.0012		12	0.00017		0.0013		

Table D-5 ANOVA of potassium content in soybean in different fertilizer treatments in the alley and the non-alley plots.

Source of variation	Potassium content (%)												
	R2			R5					R8				
				Stem			Pod		Stem			Seed	
	DF	MS	P	DF	MS	P	MS	P	DF	MS	P	MS	P
Alley													
Replication (A)	3	0.0053	0.2637	3	0.0155	0.2098	0.0002	0.9955	4	0.0198	0.0384	0.0041	0.2417
Fertilizer (B)	3	0.0852	0.0001	3	0.0220	0.1148	0.0741	0.0075	3	0.0239	0.0278	0.0034	0.3111
A*B	9	0.0034		9	0.0084		0.0097		12	0.0055		0.0026	
Non-alley													
Replication (A)	2	0.0931	0.0348	2	0.0196	0.0791	0.0077	0.4264	4	0.2640	0.0078	0.0027	0.1270
Fertilizer (B)	3	0.0727	0.0484	3	0.0701	0.0039	0.1501	0.0018	3	0.0438	0.4423	0.0019	0.2377
A*B	6	0.0150		6	0.0049		0.0078		12	0.0455		0.0012	

Appendix E Data of soil component

Table E-1 Cumulative soil loss (t/ha) at different period during peanut crop in the alley and the non-alley plot

Time	Treatment							
	MA1P1		MA1P0		MA0P1		MA0P0	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Alley								
June 24	12.63	58.94	74.27	28.80	24.76	7.17	30.82	44.20
July 7	56.08	33.25	101.00	30.37	82.86	32.16	60.63	22.33
July 21	66.70	28.32	90.95	26.95	90.94	36.22	76.29	28.45
Aug. 4	55.58	31.55	75.79	40.10	98.02	52.19	77.81	3.50
Aug. 18	65.68	19.49	112.20	27.79	93.98	25.90	86.91	44.17

Time	Treatment							
	NA1P1		NA1P0		NA0P1		NA0P0	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Non-alley								
June 24	71.60	46.89	68.82	21.08	57.73	29.14	51.62	27.81
July 7	67.16	30.03	33.30	31.77	90.47	54.96	61.05	40.52
July 21	82.70	34.22	66.61	29.04	112.70	46.93	103.20	50.48
Aug 4	72.16	25.44	61.06	41.91	133.20	33.30	155.40	41.91
Aug 18	111.00	34.98	62.17	85.58	139.90	46.98	153.20	48.03

Note : MA0, NA0 = non-mulching in the alley and the non-alley plots
MA1, NA1 = mulching in the alley and the non-alley plots
P0 = no-phosphate
P1 = with phosphate

Table E-2 Soil moisture content (% by weight) between 0-10, 10-30 and 30-50 cm. soil depth on mulching and non-mulching plot during peanut growing period in the alley and the non-alley field.

Time	Mulching						Non-mulching					
	0-10		10-30		30-50		0-10		10-30		30-50	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Alley												
June 9	25.81	1.01	19.25	8.95	20.38	11.24	23.53	2.81	19.66	2.29	22.76	0.83
June 24	26.49	3.25	24.42	1.34	24.83	0.85	26.31	0.85	25.10	2.57	26.06	0.62
July 7	27.64	1.84	25.34	0.97	24.65	1.66	27.67	2.09	25.98	4.01	25.47	0.73
July 21	28.45	3.48	22.11	1.20	22.29	0.58	25.99	3.78	21.48	0.88	22.64	2.22
Aug 4	29.01	0.40	25.35	1.15	27.13	2.65	26.95	4.14	26.11	0.22	25.41	0.82
Aug 18	22.85	2.64	21.74	2.60	23.32	3.64	23.89	2.56	22.39	1.91	24.39	0.80
Sept 1	27.22	1.87	27.30	1.29	27.40	0.37	27.67	1.59	26.16	0.97	26.28	1.44
Sept 15	27.73	3.01	25.47	1.93	25.41	2.27	27.75	1.95	24.16	0.96	24.94	1.55
Non-alley												
June 24	30.05	1.94	26.58	0.88	27.02	0.59	27.53	2.43	26.61	0.77	27.19	0.47
July 7	26.76	0.47	26.18	0.14	26.29	0.65	26.43	2.66	25.57	1.33	26.10	0.69
July 21	28.23	4.13	25.50	1.49	27.66	1.90	27.09	1.56	24.72	1.08	26.70	0.32
Aug 4	31.15	2.90	25.93	2.38	27.36	1.23	27.63	0.76	25.59	0.71	28.05	1.02
Aug 18	24.70	1.32	24.88	1.33	27.42	1.05	22.02	0.96	24.06	0.55	26.61	0.58
Sept 1	28.29	0.67	27.11	1.56	28.40	1.64	29.08	1.76	25.95	0.78	28.27	1.56
Sept 15	29.60	1.55	26.78	0.51	27.07	0.42	29.67	1.29	26.36	0.30	29.15	0.92

Table E-3 Soil moisture content (% by weight) between 0-10, 10-30 and 30-50 cm. soil depth on fertilizer and non-fertilizer plot during soybean growing period in the alley and the non-alley.

Time	Fertilizer						No fertilizer					
	0-10		10-30		30-50		0-10		10-30		30-50	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Alley												
Sep 29	20.35	1.60	21.23	1.90	24.14	4.09	21.06	3.46	22.65	0.70	23.29	1.31
Oct 14	23.96	1.58	25.48	0.79	26.98	0.33	23.68	3.31	23.14	2.37	23.92	2.33
Oct 27	21.23	1.43	22.66	0.58	23.05	2.40	21.54	2.33	22.85	0.46	25.40	0.55
Nov 10	28.20	1.16	25.96	1.25	25.53	1.26	28.65	0.45	25.94	1.08	27.97	2.21
Nov 24	13.82	0.61	17.56	0.98	21.24	2.13	14.05	1.37	17.04	0.46	21.41	1.02
Dec 9	11.00	0.68	13.02	3.39	20.43	6.94	11.78	0.74	14.75	0.87	18.37	1.96
Non-alley												
Sep 29	22.55	0.29	22.21	1.04	26.05	1.41	22.57	4.22	23.15	2.79	27.92	4.37
Oct 14	23.39	1.84	26.98	2.07	26.74	0.68	23.64	0.46	26.04	1.13	27.12	0.57
Oct 27	22.92	0.61	24.81	1.29	26.45	1.04	20.61	0.75	24.99	1.15	27.16	0.36
Nov 10	27.81	1.41	27.64	0.18	28.37	2.18	28.13	0.93	27.80	0.57	28.98	0.97
Nov 24	14.35	1.14	19.14	0.90	23.51	1.08	14.89	2.12	19.78	0.88	23.88	2.08

Appendix F Return to labor

Table F.1 Production cost of alley and non-alley farm during cropping season from May to December, 1990.

	Alley farm[1] (baht/ha)	Non-alley farm[2] (baht/ha)
1 Peanut		
- seed	1,055.48	-
- fertilizer	532.48	-
2 Soybean		
- seed	278.00	579.77
- fertilizer	892.18	737.88
- chemical	94.13	777.38
- threshing (machine)	215.38	410.44
3 Upland rice		
- seed	-	156.25
Total cost	3,067.65	2,661.72

Note : (1) estimated from the participant farmer. One hectare of alley field consisted of hedgerows, field crop and fruit trees which had ratio equal 3:5:2 or 0.3:0.5:0.2 ha.

(2) Non-alley farm was estimated from four to six farmers in Ban Huay Som Sook. One hectare consisted of field crop only.

Table F.2 Crop yields and income of alley and non-alley farm during cropping season from May to December, 1990.

Crop	Alley		Non-alley	
	Yield (kg/ha)	Income (baht/ha)	Yield (kg/ha)	Income (baht/ha)
1 Peanut	240.25	6,246.50	-	-
2 Soybean	538.46	8,974.33	998.44	11,682.42
3 Upland rice	-	-	1,892.38	4,730.95
Total income		15,220.83		16,413.37

Note : price of peanut = 26 baht/kg
price of soybean (seed) = 16.65 baht/kg
price of upland rice = 2.5 baht/kg

Table F-3 Labor used in crop production of alley and non-alley farms during cropping season from May to December, 1990

	Alley farm (man-day/ha)	Non-alley farm (man-day/ha)
1. Peanut		
. land preparation	12.75	-
. sowing	4	-
. pruning (2 times)	18.48	-
. weeding and fertilizer	29.25	-
. harvesting	32.82	-
Total	97.6	-
2. Soybean		
. land preparation	52.7	56.25
. sowing	30.33	23.31
. pruning (2 times)	18.64	0
. watering	13.22	0
. weeding and fertilizer	52.36	32.00
. spraying	1.18	15.06
. field observation	30.33	0
. harvesting	24.91	18.63
. threshing	2.2	4.19
Total	225.87	149.44
3. Upland rice		
. land preparation	-	77.06
. sowing	-	39.81
. weeding	-	88.00
. harvesting	-	42.00
. threshing	-	25.19
Total	-	272.06
Overall total labor use	323.47	421.50

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