CHAPTER V

OPTIMAL FARM PLANNING

The purpose of optimal farm planning in this study is to investigate how optimal on farming system should be if one is to maximize long term profit or return under the prevailing situation in the LRA and how income can be raised from efficient use of farm resources. The planning model is designed to include activities and constraints existing in the LRA. Parameters or coefficients of various constraints are the results of data (in Chapter III and IV). Sensitivity analysis would be employed to investigated the impact of price changes and different conditions of resources on the optimum farm plan.

The time horizon of the model is 10 years because those activities are predominantly annual crops and only one perennial specy is a mango cultivar. The planning horizon will depend on this perennial age, basically. According to the available data, mango trees at 7 to 10 years of age are found to cost and yield at a certain level, constantly. Once the 15 years plan is examined the solution to cropping patterns and sizes is the same as in the 10 years plan, except the present value of total net income. Thus, 10 years plan is used for planning and evaluation of alternatives generated by sensitivity analyses.

The planning model is self perpetuating and its total period performs on a yearly interval. Cash saving generated in a year is transferred as capital to the following year. Consumption is designed to vary positively with the annual income level. Thus, a

multi-period linear programming is employed in the planning and GULP linear programming package is used.

The following sections are concerned with the activities and constraints included in the model.

5.1 The Objective Function

The planning model was designed to maximize the net present value of the total net income of the entire farm. This income was derived from all farm activities income and off-farm income after deducting the total farm operating costs and hired labor cost.

The total net income would be discounted at 10% to a net present value. This discount rate was based on the interest rate of the government bond given to compensate for land expropriation under the land reform programme.

5.2 Activities

There were a total of 8 activities in the model. They were crop activities, crop production activities, total production cost activity, hired labor cost activities, wage labor activities, total net income activity, consumption activity and cash transferred activity.

5.2.1 Crop Activities

Those major crops found in the Chom Thong LRA were assigned as the activities in this plan. Soybean (SB), tobacco (TB), tomato

(TM), mango (MG), soybean - mango (SBMG), tobacco - mango (TBMG) and tomato - mango (TMMG) were 7 main farm activities suitable for most of the area. Therefore, these activities were included in the basic farm plan model. Once farmers preferred to grow only soybean or mango. At that time, it was necessary to drop tobacco and tomato activities out of the basic model. For more details, it was discussed in section 5.6.

5.2.2 Crop Production Activities

There were four types of production activities :production of soybean (PSB), production of tobacco (PTB), production of tomato (PTM) and production of mango (PMG). The production of each crop was derived from its yield times its activity area. This total crop production times its price to equal the gross income of that crop.

5.2.3 Total Production Cost Activity (CST)

The total production cost which could be referred to as "capital" arrived at by totaling all of the operating costs or variable costs of all types of activities. The model also considered the opportunity cost of this money so that every baht of the budget from either cash saving transferred from the previous year or from credit sources were charged at 11.5% and counted as interest cost paid back within that year.

5.2.4 Hired Labor Activities (HL₁, HL₂)

These activities were hired labor from outside the farm in the case that available farm labor was not enough to operate those farm activities. These hired labor activities were designed to fit two seasons, i.e. peak season (August-October) (HL₁) and non-peak season (November-July) (HL₂). The hired labor demand of both seasons times wage rate at 70 baht a day as the expenses of the farm.

5.2.5 Wage Labor Activities (IO₁, IO₂)

This activity equaled the amount of farm labor in manday for off-farm work. It was also designed for two seasons. The number of manday time wage rate became off-farm income.

5.2.6 Total Net Income Activity (IT)

This activity was the sum total of the positive, zero and negative values of all types of income earned.

5.2.7 Consumption and Expense Activity (C)

This activity represented a basic need consumption and household expense which varied with the total net income. When the net whole farm income was high then this activity value also increased.

5.2.8 Cash Transfer Activity (CTR)

Cash savings was the surplus of the total net income after expenses for household consumption and expenditure were deducted. It was transferred as the budget for farming activities of the following year.

5.3 Constraints

The objective function could be influenced by various types of constraints especially all of the farm resources i.e. land, labor and capital. The following sections are intended to illustrate those important constraints and the reasons of selection.

5.3.1 Land Constraint (A)

The land which was considered was only the land inside the Chom Thong LRA where most of the areas were moderately suited for annual crops but well suited for orchards. In this study, the constraint of land referred to its size because the land holding was quite small (i.e. 5 rai/household). That meant to maximize the profit from farming activities, it had to do so within the 5 rai.

5.3.2 Labor Constraint (WF)

Similar to land constraint, labor constraint in the model emphasized the available family labor to fully work on farm inside

the LRA and be able to earn income from off-farm activities as well. Therefore, the figure indicating the labor constraint was taken from the group 1 farmers, because they occupied only the land inside LRA and they could spend all their time on their farm areas. For these reasons, an average 2.96 persons of the working labor from group 1 were selected. They included labor for both on farm and off-farm activities.

Labor constraint was presented in the form of available labor in mandays which would be called as "work force or farm labor" in this chapter. These labor constraints coded as WF_1 and WF_2 were the available labor in the peak and non - peak season, respectively. They could be presented as follows :

$$WF_1 = 2.96 \times 90 = 266.40 \text{ mandays}$$
$$WF_2 = 2.96 \times 160 = 473.60 \text{ mandays}$$

5.3.3 Capital Constraint (K)

Capital in this model specifically refers to the money used in farm operation costs inside the LRA. Cash savings transferred from the previous year was considered as the source of capital. But once the cash savings reached zero or became insufficient then farmers were allowed to borrow money from a bank or other sources of capital to cover farm operating costs.

5.3.4 Wage Labor Constraint (WL)

The study result of Chapter III showed that throughout the year, Chom Thong land reform farmers had opportunities to work off-farm, on the average, 116.19 mandays/ household or 39.25 days/person. Therefore, in this model, the wage labor constraint was allowed to work off-farm jobs in any or both seasons for not more than 116.19 mandays/household/year.

5.3.5 Yield, Workforce, Cash Cost Constraints

The average results of crops yields (Chapter IV) were used as coefficients in the model. However, more description of the coefficients relating to soybean, tobacco and tomato should be mentioned here. They are the case of the intercropping of an annual and a perennial. An annual could be intercropped within the first three years. This resulted the decrease of annual crop area from year to year because of the shading effect of a perennial.

For example : If the target area was one rai,

in year 1, the area for an annual = 0.80 rai

in year 2, the area for an annual = 0.75 rai

in year 3, the area for an annual = 0.60 rai and

in year 4-10, the area for an annual = 0.00 rai

Therefore, the coefficients of yield, work force and cash cost of the above mentioned crops must be adjusted as follows :

Intercropped Crop	Year	Yield (kg/rai)	Work force (md/rai)	Cash Cost (baht/rai)	Price (baht/rai)
Soybean	1	144.15	13.82	631.82	9.07
	2	125.72	12.05	551.00	9.07
	3	100.57	9.64	440.80	9.07
Tobacco	1	1375.85	26.78	1187.53	2.60
	2	1199.87	23.36	1035.64	2.60
	3	959.90	18.68	828.51	2.60
Tomato	1	1639.12	30.17	1136.38	2.00
	2	1429.46	26.31	991.03	2.00
	3	1143.57	21.05	792.82	2.00

5.3.6 Consumption Constraint (CON)

Consumption referred to basic consumption and household expenditures for food, clothes, health and education. The consumption level depended on household income. In other words, farmers would maximize profits just to cover their consumption. Therefore, this model was designed to do so by including the consumption constraint of the lower income farmers group in the model. The reason for doing that was to allow some minimum profit activities to become part of the solutions and to avoid overestimating results which might occur if a high consumption level was replaced. Thus , the total net income and household consumption of soybean farmers were estimated for consumption function. The following is the result :

$$CON = a + bIT \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5.1)$$

$$CON = 6779.727 + 0.183 \, IT$$

$$n = 87 \quad \text{F-value} = 25.64 \quad \text{P-value} = 0.00$$

$$R^2 = 0.2317 \quad \text{adj} - R^2 = 0.2227$$

Where CON = Consumption

a = Minimum consumption

IT = Total net income

This function showed that the minimum consumption needs of the Chom Thong LR farmers were at least 6779.727 baht/household/ year.

And from the above mentioned objective, activities and constraints; the planning model, linear equations and their matrix could be drawn out as follows (Table 5.1) :

$$
\begin{aligned}
\text{Max (NPV)} &= C \, (IT) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5.2) \\
&= c_1 \, (9.07PSB_1 + 2.6PTB_1 + 2PTM_1 - 1.115CST_1 \\
&\quad - 70HL_{11} - 70HL_{21} + 70IO_{11} + 70IO_{21}) + c_2 \\
&\quad (9.07PSB_2 + \ldots) + \ldots + c_{10}(9.07PSB_{10} + 2.6PTB_{10} + \\
&\quad 2PTM_{10} + 3PMG_{10} - 1.115CST_{10} - 70HL_{110} - 70HL_{210} + \\
&\quad 70IO_{110} + 70IO_{210})
\end{aligned}
$$

subject to : The following constraints or equations

$$FGM = 9.07PSB+2.6PTB+2PTM+3PMG-1.115CST-70HL_1-70HL_2+70IO_1+70IO_2-IT \qquad = 0 \quad\ldots\ldots\ldots (5.3)$$

$$IB = IT - C - CTR \qquad = 0 \quad\ldots\ldots\ldots (5.4)$$

$$CON = -0.183IT + C \qquad \geq 6779.727 \quad\ldots (5.5)$$

$$YSB = 167.62SB + 144.15SBMG - PSB \qquad = 0 \quad\ldots\ldots (5.6)$$

$$YTB = 1599.83TB + 1375.85TBMG - PTB = 0 \quad\ldots\ldots (5.7)$$

$$YTM = 1905.95TM + 1639.12TMMG - PTM = 0 \quad\ldots\ldots\ldots (5.8)$$

$$YMG = 704MG + 704SBMG + 704TBMG +704TMMG - PMG \qquad = 0 \quad\ldots\ldots (5.9)$$

$$WF_1 = 16.07SB + 31.14TB + 35.08\ TM + 5.48\ MG + 19.3\ SBMG + 32.26\ TBMG + 35.65\ TMMG - HL_1 + IO_1 \qquad \leq 266.4 \quad\ldots\ldots (5.10)$$

$$WF_2 = 10.96MG + 10.96SBMG + 10.96TBMG + 10.96\ TMMG - HL_2 + IO_2 \qquad \leq 473.6 \quad\ldots\ldots (5.11)$$

$$WL = IO_1 + IO_2 \qquad \leq 116.19 \quad\ldots (5.12)$$

$$A = SB + TB + TM + MG + SBMG + TBMG + TMMG \qquad \leq 5 \qquad (5.13)$$

$$K = 734.67SB + 13.80TB + 1321.37TM + 880MG + 1511.82SBMG + 2069.53\ TBMG + 2016.38\ TMMG - CST \qquad = 0 \quad\ldots\ldots (5.14)$$

Table 5.1 Multiperiod Linear Model for Optimum Farm Planning of Choe Thong Land Reform Area

Note : The size of matrix is 120×190

Activities (columns):

Abbrev.	Description
SB	soybean activity
TB	tobacco activity
TM	tomato activity
MG	mango activity
SBMG	soybean intercropped with mango activity
TBMG	tobacco intercropped with mango activity
TMMG	tomato intercropped with mango activity
PSB	production of soybean
PTB	production of tobacco
PTM	production of tomato
PMG	production of mango
CST	total production costs
HL1	hired labor in peak season
HL2	hired labor in non peak season
IO1	wage labor in peak season
IO2	wage labor in non peak season
IT	total net income in baht
C	consumption expenses in baht
CTR	cash transferred to following year in baht

Constraints (rows):

Abbrev.	Description
IB	income balance
FGM	whole farm gross margin
CON	consumption equation
YSB	soybean yield
YTB	tobacco yield
YTM	tomato yield
YMG	mango yield
WF1	available work force in peak season
WF2	available work force in non peak season
WL	wage labor constraint
A	land constraint
K	farm cash costs
RHS	right hand side
NPV	net present value of total net income
	discounted at 10%
Obj	objective function

5.4 Basic Optimum Farm Plan (BFP)

This section discusses the determination of the basic optimum plan by the process of the multiperiod linear programming under the basic conditions as following :

farm area   = 5 rai

farm work force = 2.96   persons   which   provide 266.40 mandays in peak season and 473.60 mandays in non-peak season

soybean price   = 9.07 baht/kg.

tobacco price   = 2.60 baht/kg.

tomato price   = 2.00 baht/kg.

mango   price   = 3.00 baht/kg.

It was found that to obtain the optimum solution, the farmers should grow solely tobacco for 5 rai through the planning horizon. There was no need to hire labor and meanwhile they could earn income from wage labor during off season. The net present value of the total net income throughout the 10 years equalled to 291, 595 baht. (Table 5.2)

Table 5.2 also shows that parts of the total net income obtained from tobacco production and wage labor each year were adequate for household basic needs and consumption. Its surplus was cash transferred to the following year. However, it is significant that the total net income increased every year inspite of the fact that farm and wage labor incomes were constant. This was due to the accumulation of cash savings of the previous years.

Table 5.2   Income,Expense and Cash Saving Profiles of Basic Optimum Farm Plan

Year	Activity		Hired labor	Income				Household expense	Cash saving
	Types	Area rai	manday	Farm %	Wage %	Pre.yr. saving %	Total baht	baht	baht
1	TB	5	0	61.70	38.30	0	21233	10667	10566
2	TB	5	0	41.19	25.58	33.23	31798	12601	19197
3	TB	5	0	32.40	20.12	47.48	40429	14182	26247
4	TB	5	0	27.59	17.13	55.28	47480	15473	32007
5	TB	5	0	24.60	15.28	60.12	53239	16528	36711
6	TB	5	0	22.61	14.04	63.36	57944	17389	40555
7	TB	5	0	21.20	13.16	65.64	61788	18093	43695
8	TB	5	0	20.17	12.53	67.30	64927	18668	46259
9	TB	5	0	19.41	12.05	68.54	67492	19138	48354
10	TB	5	0	18.83	11.69	69.49	69588	19514	50074

Total NPV   291595

Table 5.3   Resource Utilization and Opportunity Costs of Resources of Basic Optimum Farm Plan

Year	Land		Capital		Work Force (a)		Work Force (b)		Wage labor	
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	8780.39	0	3.74	110.7	0	357.41	0	0	234.6
2	0	7833.14	0	3.33	110.7	0	357.41	0	0	209.29
3	0	6939.77	0	2.95	110.7	0	357.41	0	0	185.42
4	0	6086.69	0	2.59	110.7	0	357.41	0	0	162.63
5	0	5260.48	0	2.24	110.7	0	357.41	0	0	140.55
6	0	4447.94	0	1.89	110.7	0	357.41	0	0	118.84
7	0	3636.07	0	1.55	110.7	0	357.41	0	0	97.15
8	0	2805.8	0	1.19	110.7	0	357.41	0	0	74.97
9	0	1936.96	0	0.82	110.7	0	357.41	0	0	51.75
10	0	1011.29	0	0.43	110.7	0	357.41	0	0	27.02
Summation	0	48738.53	0	20.73	1107	0	3574.1	0	0	1302.22

Notes : (a) =   Farm work force in the season
         (b) =   Farm work force off the season

Table 5.3 shows that land resource was totally used every year. During the ten year planning, if a farmer could add another rai to grow tobacco in the first year it would result in an increase of the NPV about 8,780 baht above the 10 year NPV of the basic farm plan's total net income.

Similarly, if he did it in year 10 then the profit increment would be only 1,011.29 baht. And if he did it every year throughout 10 years then he would gain 48,738.53 baht more. In other words, he would earn a total of 340,333.53 baht or 117% of the basic farm plan profit. Similarly, if capital in terms of farm operating cost was increased by one baht more every year, then at the end of the planning the total profit would increase 20.70 baht more.

As for farm labor, 155.70 mandays of family labor were available during the production season. For the given levels of land and capital, this amount of farm labor was more than enough and about 110 mandays were left unused. Consequently, opportunity cost of farm labor reached zero. Wage labor constraintshowed an opposite tendency to farm labor constraint.Thus one additional manday (if available) to work off-farm during off-season would bring about 235 baht in the first year. It was found that one manday was continuously engaged through out 10 years it would add 1,302 baht to the total NPV.

5.5 Sensitivity Analysis

5.5.1 Changes in Farm Size

Because the farm sizes of the Chom Thong LR farmers varied from 2 to 10 rai, sensitivity analyses for the area were conducted to find out the optimum solution when the farm size changed. The solution was that if a farm size was smaller than 8.55 rai while the other constraints were constant then solely tobacco (TB) still gave the best result. And if the area was bigger than 8.55 rai then diversified farming systems were dominant. For example, Table 5.4 shows that in the case of 10 rai, the farmers should grow solely tobacco (TB) in the larger plot (8.25 rai) and integrated tobacco with mango (TBMG) in the smaller plot (1.75 rai). Subsequently, from year 4 to 10 there would be only tobacco (TB) and mango (MG) in 8.25 and 1.75 rai, respectively.

Table 5.4 also shows that hired labor was required during the first three years. As for the rest of the planning profile, the available farm work force in peak season was totally used. The net present value of 10 years total net income was equalled to 477,581 baht which was 1.64 times of the basic optimum farm plan at 5 rai.

Table 5.4 Income, Expense and Cash Saving Profiles
When Farm Area Equals 10 rai

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
	Types	Area rai	manday	Farm %	Wage %	Pre.yr. saving %	Total baht	baht	baht
1	TB,TBMG	8.25,1.75	46.96	71.64	28.36	0	28681	12031	16650
2	TB,TBMG	8.25,1.75	40.97	46.76	17.47	35.77	46550	15303	31247
3	TB,TBMG	8.25,1.75	32.76	34.54	13.52	51.94	60158	17794	42364
4	TB, MG	8.25,1.75	0	31.80	10.98	57.22	74041	20337	53704
5	TB, MG	8.25,1.75	0	28.07	9.46	62.47	85964	22520	63444
6	TB, MG	8.25,1.75	0	26.72	8.33	64.95	97675	24664	73011
7	TB, MG	8.25,1.75	0	24.28	7.59	68.13	107161	26401	80760
8	TB, MG	8.25,1.75	0	22.64	7.08	70.28	114911	27820	87091
9	TB, MG	8.25,1.75	0	21.46	6.71	71.83	121242	28979	92263
10	TB, MG	8.25,1.75	0	20.58	6.43	72.99	126413	29913	96500

| Total NPV | | | | | | | 477581 | | |

Table 5.5 Resource Utilization and Opportunity Costs of Resources
When Farm Area Equals 10 rai

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	1474.99	0	3.74	0	234.6	338.19	0
2	0	1315.86	0	3.33	0	209.29	338.19	0
3	0	1165.79	0	2.95	0	185.42	338.19	0
4	0	1022.48	0	2.59	0	162.63	338.19	0
5	0	883.69	0	2.24	0	140.55	338.19	0
6	0	747.19	0	1.89	0	118.84	338.19	0
7	0	610.81	0	1.55	0	97.15	338.19	0
8	0	471.34	0	1.19	0	74.97	338.19	0
9	0	325.38	0	0.82	0	51.75	338.19	0
10	0	787.79	0	0.43	0	27.02	338.19	0

| Summation | 0 | 8805.32 | 0 | 20.73 | 0 | 1302.22 | 3381.9 | 0 |

Notes : (a) = Farm work force in the season
(b) = Farm work force off the season

Observing Table 5.5 for resource utilization land, capital and peak season work force were totally used. The total opportunity cost of land constraint was about 18% of the basic optimum farm plan. The cause which diminished the opportunity cost of land was that to expand planted area above 8.55 rai.It was needed to hire labor. This affected the lower profit or lower return on land. However, they were the same for capital and work force constraints in both conditions.

5.5.2 Changes in Farm Labor

Farm labor from 1-4 persons were tested to determine the changes of solution. It was found that if farm labor was equal to or greater than two persons, tobacco alone (TB) for five rai was the best solution as it was in the basic farm plan's solution. On the other hand, if farm labor was one person only, one should grow tobacco (TB) and tobacco intercropped mango (TBMG) for 2.44 and 2.56 rai, respectively. In this case hired labor was required in the season during the first three years. Also, during the off-season,wage labor could earn income for a full 116.19 days every year. The change of the cropping pattern affected the decline of the total net income which was equal to 207,343 baht or 71% of the basic farm plan's income (Table 5.6).

It should be added that the factor affecting the change of the cropping pattern from TB to TB and TBMG was the farm labor limitation. It was found that to produce one rai of tobacco required 31.14 mandays of the total labor. Therefore, with90 mandays of available farm labor one could produce tobacco

Table 5.6　Income, Expense and Cash Saving Profiles
When Farm Labor Equals 1 person

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
| | Types | Area | | Farm | Wage | Pre.yr. saving | Total | | |
		rai	manday	%	%	%	baht	baht	baht
1	TB,TBMG	2.44,2.56	65.57	37.35	62.65	0	12982	9157	3825
2	TB,TBMG	2.44,2.56	59.81	35.66	43.76	20.58	18586	10183	8404
3	TB,TBMG	2.44,2.56	47.83	23.87	37.44	38.69	21721	10757	10964
4	TB, MG	2.44,2.56	-	32.57	28.72	38.71	28321	11965	16356
5	TB, MG	2.44,2.56	-	29.15	23.53	47.32	34563	13108	21455
6	TB, MG	2.44,2.56	-	30.44	19.12	50.44	42539	14569	27970
7	TB, MG	2.44,2.56	-	26.23	16.62	57.15	48938	15740	33197
8	TB, MG	2.44,2.56	-	23.69	15.02	61.29	54165	16697	37468
9	TB, MG	2.44,2.56	-	21.96	13.92	64.12	58435	17479	40956
10	TB, MG	2.44,2.56	-	20.73	13.13	66.14	61923	18112	43812

Total NPV							207343		

Table 5.7　Resource Utilization and Opportunity Costs of Resources
When Farm Labor Equals 1 person

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	1474.99	0	3.74	0	234.5	15.75	0
2	0	1315.86	0	3.33	0	209.29	15.75	0
3	0	1165.79	0	2.95	0	185.42	15.75	0
4	0	1022.75	0	2.59	0	162.63	15.75	0
5	0	883.69	0	2.24	0	140.55	15.75	0
6	0	747.19	0	1.89	0	118.84	15.75	0
7	0	610.81	0	1.55	0	97.15	15.75	0
8	0	471.34	0	1.19	0	74.97	15.75	0
9	0	943.29	0	0.92	0	31.91	15.75	0
10	0	169.88	0	0.43	0	27.02	15.75	0

Summation	0	8805.59	0	20.73	0	1282.38	157.5	0

Notes:　(a) =　Farm work force in the season
　　　　(b) =　Farm work force off the season

alone for a maximum 2.89 rai. But in order to obtain the optimum solution other unlimited resources i.e. land and capital had to be considered as well. Therefore, the less labor demanding activity, tobacco-mango intercropping, was included in the solution as a substitute in some tobacco area and to fulfill the rest of the entire farm area.

The land, capital and farm labor in the season were completely used. The off-season farm labor was left for 15.75 mandays/year (Table 5.7). The opportunity costs of those unused constraints were similar to those under the condition when farm size changed.

The result also showed that if one had a small amount of farm labor, he could be self-subsistent on his farm by managing for the appropriate cropping patterns and production sizes. At a certain period he needed to depend on hired labor to compensate for these inadequate farm labor demand.

However, if one had an additional condition of mono tobacco preference, then he could cultivate it fully in 5 rai by hiring labor every year for 65.7 mandays/year throughout the 10 year plan (Table 5.8 condition 1). The NPV of monocrop tobacco is slightly lower than that of tobacco and tobacco-mango (Table 5.6).

Those results indirectly confirmed the findings (in Chapter IV) that if one had a limitation of farm labor and insufficient capital to hire labor and in some cases to pay for material inputs then he could hardly grow tobacco on his full

area, he should grow it partially to optimize the profit as shown by condition 2 in Table 5.8.

Table 5.8 Activities, Hired Labor and Total Net Income Under Two Different Conditions

| | Condition 1 | | | Condition 2 | | |
| | Activity | | Hired labor | Total net income | Activity | | Hired labor | Total net income |
Year	Types	Area rai	manday	baht	Types	Area rai	manday	baht
1	TB	5	65.7	16634	TB	2.89	0	15705
2	TB	5	65.7	23442	TB	2.89	0	21755
3	TB	5	65.7	29004	TB	2.89	0	26697
4	TB	5	65.7	33548	TB	2.89	0	30735
5	TB	5	65.7	37259	TB	2.89	0	34033
6	TB	5	65.7	40291	TB	2.89	0	36727
7	TB	5	65.7	42768	TB	2.89	0	38928
8	TB	5	65.7	44791	TB	2.89	0	40726
9	TB	5	65.7	46444	TB	2.89	0	42194
10	TB	5	65.7	47794	TB	2.89	0	43394
Total NPV				206039				188765

Notes: Condition (1) = the condition with labor limitation and mono tobacco preference

Condition (2) = the condition with labor and capital limitations

5.5.3 Changes in Prices

In this section, the different price levels of crops and tree are examined to find out the best solution and to estimate the appropriate production patterns and size to optimize the total present value of net income.

Tobacco prices at 2.40 - 2.50 baht/kg were tested; tomato prices were examined at 2.10 - 2.20 baht/kg; and mango price levels (i.e. 4.00 - 5.00 baht/kg) were investigated.

5.5.3.1 Changes in Tobacco Price

As a result of the basic farm plan (BFP), it was clear that if tobacco prices were equal to or above 2.60 baht/kg. then the tobacco pattern was definitely found to be the solution. Therefore, it was necessary to examine the result when its prices were lower than 2.60 baht/kg. At a price of 2.50 baht/kg of tobacco price, tobacco alone was the best solution. When it decreased to 2.40 baht, the solution showed that tomato alone was better. Therefore, tomato was cultivated to replace tobacco for the full area for the whole planning horizon (Table 5.9). In other words, a decrease in tobacco area tended to occur when tobacco prices decreased to 2.40 baht or less.

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Table 5.9   Income,Expense and Cash Saving Profiles
When Tobacco Price Equals 2.40 baht / kg.

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
	Types	Area rai	manday	Farm %	Wage %	Pre.yr. saving %	Total baht	baht	baht
1	TM	5	0	58.98	41.02	0	19826	10410	9416
2	TM	5	0	39.99	27.81	32.20	29242	12134	17108
3	TM	5	0	31.66	22.02	46.32	36935	13542	23392
4	TM	5	0	27.06	18.82	54.13	43218	14693	28525
5	TM	5	0	24.18	16.82	59.00	48351	15633	32719
6	TM	5	0	22.25	15.48	62.27	52545	16401	36144
7	TM	5	0	20.89	14.53	64.58	55970	17028	38942
8	TM	5	0	19.90	13.84	66.26	58769	17540	41228
9	TM	5	0	19.15	13.32	67.53	61054	17959	43096
10	TM	5	0	18.58	12.93	68.49	62922	18294	44627

Total NPV   265426

Table 5.10   Resource Utilization and Opportunity Costs of Resources
When Tobacco Price Equals 2.40 baht / kg.

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	7837.51	0	3.74	91	0	357.41	0
2	0	6991.98	0	3.33	91	0	357.41	0
3	0	6194.54	0	2.95	91	0	357.41	0
4	0	5433.07	0	2.59	91	0	357.41	0
5	0	4695.59	0	2.24	91	0	357.41	0
6	0	3970.3	0	1.89	91	0	357.41	0
7	0	3245.62	0	1.55	91	0	357.41	0
8	0	2504.5	0	1.19	91	0	357.41	0
9	0	1728.96	0	0.82	91	0	357.41	0
10	0	902.69	0	0.43	91	0	357.41	0
Summation	0	43504.76	0	20.73	910	0	3574.1	0

Notes : (a) =   Farm work force in the season
(b) =   Farm work force off the season

Other crop activities to substitute for tobacco could be any kinds which provided better profit. At this point, tomato was the best option when compared to soybean and mango. The result also showed that the total net income was 265,426 baht or 91% of the BFP's. The opportunity cost of land constraint totalled 43,504.76 baht (or was 88% of the value appeared in the BFP) (Table 5.10). Meanwhile, the opportunity costs of other resources were the same as those which appeared in the basic solution. From these results, tomato seemed to be one of the interesting choices which possibly replaced tobacco in the case that the tobacco role in agriculture decreased.

5.5.3.2 Changes in Tomato Price

In this section, the study intended to investigate the impact of tomato prices which varied above the original 2.00 baht/kg. The result illustrated that when the price rose to 2.10 baht/kg. tobacco was still dominant. And if the tomato price rose to 2.20 baht (and tobacco price equalled 2.60 baht), tomato could substitute for tobacco (Table 5.11).

A tomato price at 2.20 baht/kg. resulted in an increment of a total net profit only 0.03% of the BFP. Similarly, the opportunity cost of land constraint in this case was 1.03 times of the result in the BFP. (Table 5.12)

Again it should be stressed that tomato was one of the important cashcrops, especially when tobacco demand was declining. It was chosen because it could provide about the same total net

present income and required a similar amount of resources either labor and capital as tobacco did.

Table 5.11   Income, Expense and Cash Saving Profiles
When Tomato Price Equals 2.20 baht / kg.

| Year | Activity | | Hired labor | Income | | | Household | | Cash saving |
| | Types | Area | | Farm | Wage | Pre.yr. saving | Total | expense | |
		rai	manday	%	%	%	baht	baht	baht
1	TM	5	0	62.57	37.43	0	21732	10759	10973
2	TM	5	0	41.58	24.87	33.55	32705	12768	19937
3	TM	5	0	32.64	19.52	47.85	41669	14409	27260
4	TM	5	0	27.76	16.60	55.64	48992	15750	33242
5	TM	5	0	24.74	14.79	60.47	54974	16845	38129
6	TM	5	0	22.72	13.59	63.70	59861	17740	42121
7	TM	5	0	21.30	12.74	65.97	63853	18471	45382
8	TM	5	0	20.26	12.12	67.62	67114	19068	48046
9	TM	5	0	19.49	11.66	68.86	69777	19556	50221
10	TM	5	0	18.90	11.30	69.80	71954	19947	52006

| Total NPV | | | | | | | 300883 | | |

Table 5.12   Resource Utilization and Opportunity Costs of Resources
When Tomato Price Equals 2.20 baht / kg.

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	9115.04	0	3.74	91	0	357.41	0
2	0	8131.69	0	3.33	91	0	357.41	0
3	0	7204.26	0	2.95	91	0	357.41	0
4	0	6318.67	0	2.59	91	0	357.41	0
5	0	5460.98	0	2.24	91	0	357.41	0
6	0	4617.46	0	1.89	91	0	357.41	0
7	0	3774.65	0	1.55	91	0	357.41	0
8	0	2912.74	0	1.19	91	0	357.41	0
9	0	2010.78	0	0.82	91	0	357.41	0
10	0	1049.83	0	0.43	91	0	357.41	0
Summation	0	50596.1	0	20.73	910	0	3574.1	0

Notes : (a) =   Farm work force in the season
(b) =   Farm work force off the season

5.5.3.3 Changes in Mango Price

In this section, it was found that if mango price fell below 4.00baht/kg., tobacco was the only crop in the solution. But when its price was above 5.00 baht/kg., the solution changed.Tobacco-mango system for 5 rai was the optimal solution for the entire horizon (Table 5.13). Tobacco was intercropped with mango for the first three years while mango was not fruitful. This plan does not conform to the actual practice since most farmers normally integrated only one or two rai in a year. Thus, the model suggested that in order to make a higher income the optimal solution should be adopted.

Besides the off-farm income from wage labor, tobacco provided the farm income in the first three years. Later, from year 4 to 10, tobacco disappeared and then mango replace tobacco.(Table 5.13). The total net income in this plan was not significantly different from the income of the BFP. But the advantage of this pattern was that there was unused labor resource in the season (Table 5.14). This enabled small farm households to practice this system and gain more income from off-farm opportunities.

As for the foregoing results, mango could be another choice besides tomato to replace tobacco. Mango of good varieties would be preferable (due to their high price) to tobacco, tomato or other crops.

Table 5.13   Income,Expense and Cash Saving Profiles
When Mango Price Equals   5.00 baht / kg.

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
	Types	Area rai	manday	Farm %	Wage %	Pre.yr. saving %	Total baht	baht	baht
1	TBMG	5	0	43.88	56.12	0	14493	9433	5060
2	TBMG	5	0	39.57	37.26	23.18	21831	10777	11054
3	TBMG	5	0	17.89	34.81	47.31	23367	11058	12309
4	MG	5	0	38.08	24.64	37.28	33014	12825	20189
5	MG	5	0	36.09	18.35	45.56	44313	14893	29420
6	MG	5	0	40.92	12.80	46.29	63562	18418	45144
7	MG	5	0	33.72	10.12	56.16	80378	21497	58881
8	MG	5	0	28.80	8.64	62.56	94116	24012	70104
9	MG	5	0	25.73	7.72	66.55	105338	26067	79271
10	MG	5	0	23.67	7.10	69.23	114505	27734	86771

Total NPV   308719

Table 5.14   Resource Utilization and Opportunity Costs of Resources
When Mango Price Equals   5.00 baht / kg.

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	8780.39	0	3.74	105.1	0	302.61	0
2	0	7833.14	0	3.33	122.2	0	302.61	0
3	0	6939.77	0	2.95	145.6	0	302.61	0
4	0	6086.69	0	2.59	239	0	302.61	0
5	0	5260.48	0	2.24	239	0	302.61	0
6	0	4447.94	0	1.89	239	0	302.61	0
7	0	3636.07	0	1.55	239	0	302.61	0
8	0	2805.8	0	1.19	239	0	302.61	0
9	0	5361.77	0	0.82	239	0	302.61	0
10	0	1011.29	0	0.43	239	0	302.61	0

Summation   0 52163.34   0   20.73   2045.9   0   3026.1   0

Notes : (a) =   Farm work force in the season
(b) =   Farm work force off the season

Mango and tomato seemed to be a good integration when more conditions (tobacco price fell under 2.40 baht/kg. or tomato prices rose above 2.20 baht/kg.) were included, they made tomato more beneficial than tobacco. If this occurred then tobacco would be dropped and tomato would be selected.

5.6 Farm Planning for the Northern Zone of Chom Thong LRA

The results of section 5.4 show farmers can obtain the optimum solution through tobacco cultivation for the full 5 rai. This practice is possible in any site of the Chom Thong LRA except in the northern zone area because most of the farmers in this zone prefer to grow soybean and mango. Thus, the BFP solution may not be applicable in this area. Therefore, it is necessary to determine the farm plan model specifically for the northern zone of Chom Thong LRA. This farm plan model will be coded as BFPN.

In the BFPN model it was necessary to exclude activities of TB, TM, TBMG and TMMG from the BFP model because those four activities were more profitable than soybean and their appearance never allowed for soybean in the solution. The results showed that farmers should grow soybean (SB) and soybean-mango (SBMG) in the first year for 1.91 and 3.09 rai, respectively. This provided 8,299 baht (or 2%) of the total net income which was derived only from farm income and 98% from wage labor. This farm income came entirely from soybean production of both cropping systems while mango was still not profitable. Because of this, farmers had to depend on off-farm earning as wage labor during off-season, which brought in an income of 8133.33 baht/household/year. However, this off-farm

activity was a constant profit for the whole plan horizon (Table 5.15).

Table 5.15   Income, Expense and Cash Saving Profiles in Northern LRA
When Farm Area Equals 5.00 rai

| Year | Activity | | Hired | Income | | | | Household | Cash | Capital |
| | Types | Area | labor | Farm | Wage | Pre.yr. saving | Total | expense | saving | |
		rai	manday	%	%	%	baht	baht	baht	baht
1	SB,SBMG	1.91,3.09	0	2.00	98.00	0	8299	8299	0	6777
2	SB,SBMG	1.26,3.74	0	5.96	94.04	0.00	8649	8363	286	5771
3	SB,SBMG	1.26,3.74	0	-1.45	98.00	3.45	8299	8299	0	5593
4	SB,SBMG	1.26,3.74	0	33.51	66.49	0.00	12232	9019	3213	4938
5	SB, MG	1.26,3.74	0	34.77	46.76	18.47	17395	9965	7430	5401
6	SB, MG	1.26,3.74	0	38.50	32.14	29.36	25305	11413	13892	6136
7	SB, MG	1.26,3.74	0	31.93	25.14	42.93	32357	12704	19653	7630
8	SB, MG	1.26,3.74	0	27.05	21.35	51.60	38088	13754	24334	7918
9	SB, MG	1.26,3.74	0	24.09	19.02	56.90	42770	14611	28159	7918
10	SB, MG	1.26,3.74	0	22.11	17.46	60.43	46595	15311	31284	7918

Total NPV   124856

Table 5.16   Resource Utilization and Opportunity Costs of Resources
in Northern LRA When Farm Area Equals 5.00 rai

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	3960.26	0	6.3	176.06	0	323.5	0
2	0	2480.05	0	3.94	179.43	0	316.37	0
3	0	2326.96	0	3.7	188.04	0	316.37	0
4	0	1628.96	0	2.59	219.43	0	316.37	0
5	0	1407.84	0	2.24	225.7	0	316.37	0
6	0	1190.38	0	1.89	225.7	0	316.37	0
7	0	973.11	0	1.55	225.7	0	316.37	0
8	0	750.91	0	1.19	225.7	0	316.37	0
9	0	518.38	0	0.82	225.7	0	316.37	0
10	0	270.65	0	0.43	225.7	0	316.37	0
Summation	0	15507.5	0	24.65	2117.16	0	3170.83	0

Notes : (a) =   Farm work force in the season
         (b) =   Farm work force off the season

It was found that the total net income of the first year was used entirely for household consumption, so there was no cash left to be transferred to the following year. In the second year farmers needed to rely on other capital source. In this year, farmers should expand 0.65 rai for SBMG. This resulted in a decrease of mono soybean area to 1.26 rai. This pattern and production size were constant until the fourth year, by this time mango which were planted in the first year were bearing and that resulted a cash saving increment. Therefore, it could be concluded that under these conditions mango return increased the total farm income, household consumption and cash saving. The total NPV of 10 years income was 124,856 baht/household which accounted for 43% of the BFP.

Besides this, it was observed that in year three farmers lost 120 baht per household due to the increase of mango production cost in this year while only soybean accounted for the income. However,the solution gave the same amount of total net income, household consumption, but with no cash saving as in the first year (Table 5.15).

5.7 Sensitivity Analysis for the Basic Farm Plan in Northern LRA

Under the model of BFPN, it was worthwhile to further examine the changes in farm size, labor, capital and produce prices to determine the solutions when those changes occurred.

5.7.1 Changes in Farm Size

In the northern LRA farm, sizes also varied from 5-10 rai/household. It was found that for up to ten rai the patterns in the solution were the same as in the BFPN. That was from year 1 to 4, soybean and soybean-mango cropping systems were recommended and from year 5 soybean in SBMG disappeared (Table 5.17).

As for the production sizes and costs, they were about double those in the BFPN throughout the planning horizon. It was interesting that the changes in the total net income were significant from the fourth year to the end of the plan. This confirmed the solution that mango was the important component increasing the profits. The total income NPV of the whole plan was 62% significantly larger than the BFPN's.

Table 5.17   Income,Expense and Cash Saving Profiles in Northern LRA
When Farm Area Equals 10 rai

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving | Capital |
| | Types | Area | | Farm | Wage | Pre.yr. saving | Total | | | |
		rai	manday	%	%	%	baht	baht	baht	baht
1	SB,SBMG	3.66,6.34	0	2.00	98.00	0	8299	8299	0	13687
2	SB,SBMG	2.33,7.67	0	9.80	90.20	0.00	9017	8431	586	11626
3	SB,SBMG	2.33,7.67	0	-5.06	98.00	7.06	8299	8299	0	11259
4	SB,SBMG	2.33,7.67	0	50.28	49.72	0.00	16359	9775	6584	9919
5	SB, MG	2.33,7.67	0	45.37	30.19	24.44	26942	11713	15229	10868
6	SB, MG	2.33,7.67	0	45.87	18.85	35.29	43157	14682	28475	12374
7	SB, MG	2.33,7.67	0	36.46	14.12	49.43	57611	17328	40283	15436
8	SB, MG	2.33,7.67	0	30.19	11.73	58.08	69358	19479	49879	16025
9	SB, MG	2.33,7.67	0	26.52	10.30	63.17	78955	21236	57719	16025
10	SB, MG	2.33,7.67	0	24.13	9.37	66.50	86794	22672	64122	16025

Total NPV   202394

Table 5.18   Resource Utilization and Opportunity Costs of Resources
in Northern LRA When Farm Area Equals 10 rai

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	3960.26	0	6.3	85.22	0	287.9	0
2	0	2480.05	0	3.94	92.14	0	273.29	0
3	0	2326.96	0	3.7	109.78	0	273.29	0
4	0	1628.96	0	2.59	174.13	0	273.29	0
5	0	1407.84	0	2.24	186.98	0	273.29	0
6	0	1190.38	0	1.89	186.98	0	273.29	0
7	0	973.11	0	1.55	186.98	0	273.29	0
8	0	750.91	0	1.19	186.98	0	273.29	0
9	0	518.38	0	0.82	186.98	0	273.29	0
10	0	270.65	0	0.43	186.98	0	273.29	0
Summation	0	15507.5	0	24.65	1583.15	0	2747.51	0

Notes : (a) =   Farm work force in the season
(b) =   Farm work force off the season

5.7.2 Changes in Farm Labor

Soybean and mango were not labor intensive activities. In the BFPN model,the farm work forces were found to be in surplus in both seasons so it was not necessary to examine for the larger available farm labor. However, for the smaller available farm labor it was.

Therefore, in this part, the minimum farm labor of 1 person was tested. Mono soybean and soybean - mango came into the solution which showed nearly the same results as in the BFPN. The cause for the difference was the unused land constraint which was left for 0.02 rai in the first year due to an inadequate work force. However, in the second year the production size of both cropping systems were adjusted to fit labor availability (Table 5.19 and 5.20).

This solution also illustrated that farmers with the least farm labor could manage to utilize their land resource efficiently by selecting the lower labor demand activities like soybean and mango. In so doing, hiring labor was not necessary. Meanwhile, off-farm opportunities could be engaged in fully during the off-season.

Table 5.19   Income,Expense and Cash Saving Profile in Northern LRA
When Farm Labor Equals 1   person

| Year | Activity | | Hired labor | Income | | | Total | Household expense | Cash saving | Capital |
| | Types | Area | | Farm | Wage | Pre.yr. saving | | | | |
		rai	manday	%	%	%	baht	baht	baht	baht
1	SB,SBMG	1.9,3.08	0	2.00	98.00	0	8299	8299	0	6750
2	SB,SBMG	1.26,3.74	0	5.92	94.08	0.00	8645	8363	282	5778
3	SB,SBMG	1.26,3.74	0	-1.40	98.00	3.40	8299	8299	0	5592
4	SB,SBMG	1.26,3.74	0	33.41	66.59	0.00	12214	9016	3198	4942
5	SB, MG	1.26,3.74	0	34.79	46.81	18.41	17376	9961	7415	5399
6	SB, MG	1.26,3.74	0	38.49	32.18	29.34	25276	11408	13868	6134
7	SB, MG	1.26,3.74	0	31.96	25.15	42.89	32334	12700	19634	7624
8	SB, MG	1.26,3.74	0	27.06	21.36	51.57	38070	13750	24320	7918
9	SB, MG	1.26,3.74	0	24.09	19.02	56.88	42735	14608	28147	7918
10	SB, MG	1.26,3.74	0	22.12	17.46	60.42	46582	15309	31273	7918

Total NPV   124781

Table 5.20   Resource Utilization and Opportunity Costs of Unused Resources
in Northern LRA When Farm Labor Equals 1   person

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0.02	0	0	5.57	0	217.98	10.03	0
2	0	2480.05	0	3.94	3.01	0	2.77	0
3	0	2326.96	0	3.7	11.61	0	2.77	0
4	0	1628.96	0	2.59	42.92	0	2.77	0
5	0	1407.84	0	2.24	49.3	0	2.77	0
6	0	1190.38	0	1.89	49.3	0	2.77	0
7	0	973.11	0	1.55	49.3	0	2.77	0
8	0	750.91	0	1.19	49.3	0	2.77	0
9	0	518.38	0	0.82	49.3	0	2.77	0
10	0	270.65	0	0.43	49.3	0	2.77	0
Summation	0.02	11547.24	0	23.92	353.34	217.98	34.96	0

Notes : (a) =   Farm work force in the season
         (b) =   Farm work force off the season

5.7.3 Changes in Soybean Price

In this section, the study examined data for the solution when soybean price changed from 9.07 baht/kg. while mango produce remained constant at 3.00 baht/kg. From the study it was found that if the soybean price was equal to or under 5.00 baht, the solution was infeasible, that is farmers should produce some other crops in replacement of soybean. When its price was 5.10 baht, it was recommended to grow mono soybean in almost all the 5 rai and soybean - mango intercropping between 0.01-0.04 rai in spite of the soybean's low price. This was due to the necessity that farmers had to earn income from farm activities from the beginning of the plan to meet their consumption needs, they could not lose their opportunity cost of cash investment in any year. Under this condition, the total net income of the whole plan was critically low (51,432 baht). Thus, wage labor income was highly demanded for these farmers (Table 5.21).

The study also determined that for the solution when soybean prices were equal to or above 9.07 baht. Two price levels of 10.80 and 10.90 baht were explored. It was found that at 10.80 baht, soybean monocrop and soybean - mango intercropping systems were in the best solution (Table 5.23). And if the price equalled to 10.90 baht mono soybean was dominant (Table 5.25).

Table 5.21 Income,Expense and Cash Saving Profiles in Northern LRA
When Soybean Price Equals 5.10 baht / kg.

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
| | Types | Area | | Farm | Wage | Pre.yr. saving | Total | | |
		rai	manday	%	%	%	baht	baht	baht
1	SB,SBMG	4.99,0.01	0	2.00	98.00	0	8299	8299	0
2	SB,SBMG	4.98,0.02	0	2.00	98.00	0.00	8299	8299	0
3	SB,SBMG	4.98,0.02	0	2.00	98.00	0.00	8299	8299	0
4	SB,SBMG	4.96,0.04	0	2.00	98.00	0.00	8299	8299	0
5	SB,SBMG	4.96,0.04	0	2.27	97.73	0.00	8322	8304	19
6	SB,SBMG	4.96,0.04	0	2.41	97.37	0.22	8353	8309	44
7	SB, MG	4.96,0.04	0	2.94	96.54	0.52	8425	8322	102
8	SB, MG	4.96,0.04	0	3.00	95.80	1.20	8490	8334	156
9	SB, MG	4.96,0.04	0	3.26	94.92	1.82	8569	8349	220
10	SB, MG	4.96,0.04	0	3.23	94.22	2.55	8632	8360	272
Total NPV							51432		

Table 5.22 Resource Utilization and Opportunity Costs of Resources
in Northern LRA When Soybean Price Equals 5.10 baht / kg.

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	372.24	0	11.62	186.01	0	357.21	0
2	0	242.99	0	7.59	186.01	0	357.21	0
3	0	261.36	0	8.16	186.05	0	357.21	0
4	0	122.67	0	3.83	186.12	0	356.97	0
5	0	71.69	0	2.24	186.21	0	356.97	0
6	0	60.62	0	1.89	186.26	0	356.97	0
7	0	49.55	0	1.55	186.48	0	356.97	0
8	0	38.24	0	1.19	186.48	0	356.97	0
9	0	26.4	0	0.82	186.48	0	356.97	0
10	0	13.78	0	0.43	186.48	0	356.97	0
Summation	0	1259.54	0	39.32	1862.58	0	3570.42	0

Notes : (a) =   Farm work force in the season
(b) =   Farm work force off the season

Table 5.23 showed that the planted area of soybean monocrop was smaller than 1 rai while soybean - mango intercropping absorbed the larger area. This reflected the price of soybean at 10.80 baht and mango at 3.00 baht, mango was considered to earn more profit in the long run, so it was recommended that farmers should rely in the long term activity on the larger area being used for mango. Meanwhile, the mango was not bearing, farmers could just cover their home consumption during the first three years from soybean planted in soybean and soybean intercropped mango cropping systems. At 10.90 baht, it was certain that mango could not compete with soybean at this price so the full area for soybean came into the solution for the whole plan (Table 5.25).

In conclusion when the soybean price was under 10.80 baht/kg. soybean and mango of local variety were brought into the solution under the cropping systems of soybean monocrop and soybean-mango intercropping.The production sizes were depended on soybean return from both cropping systems during the first three years and soybean and mango returns during year 4 to the end of the plan. That was at the lower price of soybean,the area for mono soybean tended to be bigger. And at the higher price, the recommended area for soybean monocrop was smaller.

Table 5.23   Income,Expense and Cash Saving Profiles in Northern LRA
When Soybean Price Equals 10.80 baht / kg.

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
	Types	Area rai	manday	Farm %	Wage %	Pre.yr. saving %	Total baht	baht	baht
1	SB,SBMG	0.72,4.28	0	2.00	98.00	0	8299	8299	0
2	SB,SBMG	0.72,4.28	0	15.43	84.57	0.00	9617	8541	1076
3	SB,SBMG	0.72,4.28	0	1.21	87.24	11.54	9323	8487	836
4	SB, MG	0.72,4.28	0	37.79	56.41	5.80	14417	9420	4998
5	SB, MG	0.72,4.28	0	34.34	40.67	24.99	19998	10441	9556
6	SB, MG	0.72,4.28	0	39.75	27.70	32.55	29362	12156	17206
7	SB, MG	0.72,4.28	0	31.18	22.09	46.73	36818	13521	23296
8	SB, MG	0.72,4.28	0	26.75	18.96	54.29	42908	14636	28271
9	SB, MG	0.72,4.28	0	23.97	16.99	59.04	47883	15547	32335
10	SB, MG	0.72,4.28	0	22.10	15.66	62.25	51947	16291	35655
Total NPV							140594		

Table 5.24   Resource Utilization and Opportunity Costs of Resources
in Northern LRA When Soybean Price Equals   10.80   baht / kg.

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	3425.23	0	3.85	172.24	0	310.54	0
2	0	2963.36	0	3.33	179.81	0	310.54	0
3	0	2625.39	0	2.95	190.11	0	310.54	0
4	0	2302.66	0	2.59	231.34	0	310.54	0
5	0	1990.1	0	2.24	231.34	0	310.54	0
6	0	1682.7	0	1.89	231.34	0	310.54	0
7	0	1375.56	0	1.55	231.34	0	310.54	0
8	0	1061.46	0	1.19	231.34	0	310.54	0
9	0	732.77	0	0.82	231.34	0	310.54	0
10	0	382.58	0	0.43	231.34	0	310.54	0
Summation	0	18541.81	0	20.84	2161.54	0	3105.4	0

Notes : (a) =   Farm work force in the season
         (b) =   Farm work force off the season

Table 5.25　Income,Expense and Cash Saving Profiles in Northern LRA
When Soybean Price Equals　10.90　baht / kg.

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
	Types	Area rai	manday	Farm %	Wage %	Pre.yr. saving %	Total baht	baht	baht
1	SB	5	0	38.26	61.74	0	13173	9192	3981
2	SB	5	0	29.38	47.41	23.21	17154	9921	7233
3	SB	5	0	24.70	39.86	35.45	20406	10516	9890
4	SB	5	0	21.85	35.27	42.88	23063	11003	12060
5	SB	5	0	19.97	32.23	47.80	25233	11400	13833
6	SB	5	0	18.66	30.12	51.22	27006	11725	15281
7	SB	5	0	17.71	28.58	53.70	28454	11990	16464
8	SB	5	0	17.00	27.44	55.55	29637	12206	17431
9	SB	5	0	16.47	26.58	56.96	30604	12383	18220
10	SB	5	0	16.05	25.91	58.04	31393	12528	18865

| Total NPV | | | | | | | 141653 | | |

Table 5.26　Resource Utilization and Opportunity Costs of Resources in
Northern LRA When Soybean Price Equals　10.90　baht / kg.

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	3377.89	0	3.74	186.05	0	357.41	0
2	0	3013.47	0	3.33	186.05	0	357.41	0
3	0	2669.79	0	2.95	186.05	0	357.41	0
4	0	2341.6	0	2.59	186.05	0	357.41	0
5	0	2023.75	0	2.24	186.05	0	357.41	0
6	0	1711.16	0	1.89	186.05	0	357.41	0
7	0	1398.83	0	1.55	186.05	0	357.41	0
8	0	1079.41	0	1.19	186.05	0	357.41	0
9	0	745.16	0	0.82	186.05	0	357.41	0
10	0	389.05	0	0.43	186.05	0	357.41	0
Summation	0	18750.11	0	20.73	1860.5	0	3574.1	0

Notes :　(a) =　Farm work force in the season
　　　　(b) =　Farm work force off the season

5.7.4 Changes in Mango Price

The increment of farm income derived from mango was feasible under two conditions :

1) when its farm gate price increased in accordance with market price, and

2) when a good variety of mango replaced the local one.

For these reasons, in this section, the study tried to examine the impact of mango price changes above or under 3.00 baht/kg. The prices between 2.70 and 3.00 baht were investigated. The cropping systems which came into the solution were similar to the ones in the BFPN. Those were soybean monocrop in combination with soybean and mango intercropping systems.

When mango price at 2.65 baht/kg., soybean was dominant in the solution. This was due to the return of mango at this price providing less profit than the return of mono soybean (Table 5.27).

When its price went above 3.00 baht/kg., it was found that at 3.75 baht/kg. of mango resulted in a different solution from the BFPN'S. The solution pattern was changed as follows: during the first three years, mono soybean was recommended in the smaller plot size while soybean and mango integration (SBMG) was recommended in the rest of the farm area. In the second year mono soybean was reduced by 0.65 rai where this area was incidentally utilized for SBMG, the second plot. This increased the SBMG area to a total of 3.74 rai. In the third year there was no change in the production sizes except an increment in mango production cost which resulted in the loss of farm income (Table 5.29).

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Table 5.27   Income,Expense and Cash Saving Profiles in Northern LRA
When Mango Price Equals 2.65 baht / kg.

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
	Types	Area rai	manday	Farm %	Wage %	Pre.yr. saving %	Total baht	baht	baht
1	SB	5	0	30.12	69.88	0	11639	8911	2728
2	SB	5	0	24.40	56.61	18.99	14367	9410	4957
3	SB	5	0	21.13	49.01	29.87	16596	9819	6777
4	SB	5	0	19.04	44.16	36.80	18417	10152	8265
5	SB	5	0	17.61	40.86	41.52	19904	10424	9480
6	SB	5	0	16.60	38.51	44.89	21119	10647	10472
7	SB	5	0	15.85	36.78	47.36	22111	10828	11283
8	SB	5	0	15.30	35.48	49.22	22922	10977	11945
9	SB	5	0	14.86	34.49	50.65	23584	11098	12486
10	SB	5	0	14.53	33.71	51.76	24125	11197	12928

Total NPV   113121

Table 5.28   Resource Utilization and Opportunity Costs of Resources in
Northern LRA When Mango Price Equals 2.65 baht / kg.

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	2349.86	0	3.74	186.05	0	357.41	0
2	0	2096.35	0	3.33	186.05	0	357.41	0
3	0	1857.26	0	2.95	186.05	0	357.41	0
4	0	1628.96	0	2.59	186.05	0	357.41	0
5	0	1407.84	0	2.24	186.05	0	357.41	0
6	0	1190.38	0	1.89	186.05	0	357.41	0
7	0	973.11	0	1.55	186.05	0	357.41	0
8	0	750.91	0	1.19	186.05	0	357.41	0
9	0	518.38	0	0.82	186.05	0	357.41	0
10	0	270.65	0	0.43	186.05	0	357.41	0
Summation	0	13043.7	0	20.73	1860.5	0	3574.1	0

Notes : (a) = Farm work force in the season
(b) = Farm work force off the season

In year four soybean monocrop was not encouraged anymore, its area was replaced by SBMG for 1.26 rai. Meanwhile, in this year mango of the first year plot (3.09 rai) started to provide a benefit return. That meant the soybean crop in SBMG cropping system in this plot was eliminated. During year 5 and 6, soybean areas under the SBMG cropping systems of the second and third year plots gradually vanished, due to the shading effect of mango. Therefore, from year seven to the end of the plan only mango was in the solution.

It was observed that when the mango price was equal to or above 3.75 baht/kg., mono soybean also came into the solution because cash investment in soybean was lower than in mango and it also returned the benefit in the same year. So it was reasonable to produce soybean in some areas to provide part of the total net income to meet the farms' consumption needs while mango was still unprofitable (Table 5.29).

This sensitivity study also showed that if farmers still planted mango, (local varieties whose produce prices were always low) then it was hard for farmers to obtain the optimum benefit from them. On the other hand, if farmers produced a good variety or managed to obtain higher profitable produce or adopted plant propagation technology to produce a higher grade then mango seemed to possibly make its growers become better-off.

Table 5.29   Income,Expense and Cash Saving Profiles in Northern LRA
              When Mango Price Equals 3.75 baht / kg.

| Year | Activity | | Hired labor | Income | | | | Household expense | Cash saving |
| | Types | Area | | Farm | Wage | Pre.yr. saving | Total | | |
		rai	manday	%	%	%	baht	baht	baht
1	SB,SBMG	1.91,3.09	0	2.00	98.00	0	8299	8299	0
2	SB,SBMG	1.26,3.74	0	5.97	94.04	0.00	8649	8363	286
3	SB,SBMG	1.26,3.74	0	-1.44	98.00	3.44	8299	8299	0
4	SBMG,MG	1.91,3.09	0	34.99	65.01	0.00	12510	9070	3440
5	SBMG,MG	1.26,3.74	0	39.34	42.63	18.03	19079	10273	8806
6	SBMG,MG	1.26,3.74	0	41.38	28.15	30.47	28897	12071	16826
7	MG	5	0	38.34	20.09	41.57	40477	14191	26286
8	MG	5	0	31.91	16.09	52.00	50553	16036	34517
9	MG	5	0	29.63	13.42	56.95	60609	17877	42732
10	MG	5	0	26.17	11.81	62.03	68891	19394	49497

Total NPV   154275

Table 5.30   Resource Utilization and Opportunity Costs of Resources in
              Northern LRA When Mango Price Equals 3.75 baht / kg.

| Year | Land | | Capital | | Work Force (a) | | Work Force (b) | |
	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost	unused	oppor. cost
1	0	5384.18	0	8.56	176.06	0	323.5	0
2	0	4474.39	0	7.12	179.43	0	316.37	0
3	0	4768.31	0	7.58	188.04	0	316.37	0
4	0	1628.96	0	2.59	215.38	0	302.61	0
5	0	1407.84	0	2.24	223.87	0	302.61	0
6	0	1190.38	0	1.89	226.9	0	302.61	0
7	0	973.11	0	1.55	239	0	302.61	0
8	0	1052.5	0	1.19	239	0	302.61	0
9	0	518.38	0	0.82	239	0	302.61	0
10	0	270.65	0	0.43	239	0	302.61	0
Summation	0	21668.7	0	33.97	2165.68	0	3074.51	0

Notes : (a) =   Farm work force in the season
         (b) =   Farm work force off the season

5.8 Summary

Programming solutions, as summarized in Table 5.31 for general sites and Table 5.32 for Northern location of Chom Thong LRA, proposed that available farm area, farm labor and output price interrelatedly resulted cropping patterns and production sizes.

For the basic available resources (i.e. land, labor and capital), about 30 % of the Chom Thong land reform farmers fully utilized their land for tobacco monocropping in relevance with the recommended solution in the basic optimal farm plan (BFP). This was found in G_{11} and G_{21} farmers who engaged their total LR farm area in tobacco monocropping system and earned 10,720 and 13,917 baht/household, respectively, from this crop (Table 4.17). These values were nonsignificantly different from the BFP farm income (13,100 baht/household) in the first year. On the contrary, in northern LRA, soybean monocrop was not recommended unless its price was equal to or above 10.90 baht/kg. Thus, those soybean monocropping farmers should consider to optimize their farm resource utilization through the diversified farming systems.

Nevertheless, off-farm income earned from off-season resulted from the programming were about twice of the actual earning. This could possibly become less if probability of finding job was accounted.

Table 5.31 Alternative Farm Plan for Choa Thong LRA Farmers

Items	Farm size (rai)		Farm labor (person)		Tobacco price (baht/kg)		Tomato price (baht/kg)		Mango price (baht/kg)	
Conditions	5-8.55	> 8.55	1	>2	<= 2.40	>= 2.50	<= 2.10	>= 2.20	<= 4.00	>= 5.00
Activity types	TB	TB	TB	TB	TB	TB	TB	TB	TB	TBMG
	-	TBMG	TBMG	-	TH	-	TH	-	-	-

Table 5.32 Alternative Farm Plan for Northern Choa Thong LRA Farmers

Items	Farm size (rai)		Farm labor (person)		Soybean price (baht/kg)		Mango price (baht/kg)	
Conditions	5	10	1	<= 5.00	5.10-10.80	10.90	<= 2.65	>= 3.75
Activity types	SB	SB	SB	SB	SB	SB	SB	SB
	SBMG	SBMG	SBMG	infeas.	-	SBMG	-	SBMG