CHAPTER IV   OPTIMUM FARM PLANS

Given the gross income of each crop, expenditure per farm family and other resource constraints, the study determines the optimum value for the objective function (the Present Net Value of total gross income of 20 years planning horizon). Results of the optimum of each group of farmers are presented, followed by discussion of sensitivity analyses.

IV.1   Initial Optimal Plan (IOP)

In order to provide a clear picture of the model formulation, Table 10 shows the simplified structure of Multi-period Linear Programming Model.

To maximize the net present value of the family income, the simplex process gives the top priority to the most profitable activity to enter the solution. The size of activity is restricted by the resource constraints given its unit uses of resources.

For multi-period model, the maximum net present value of family income arises from the same algorithm. It can solve for the best plan for a whole period among competitiveness of all activities with the optimum for any one year depending on the optimum in other years, the availability of resources and the family consumption needs.

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Table 10. Simplified Multi-period Linear Programming Model *)

ACT:		YEAR1										YEAR20											GROSS INCOME	CR20	RHS
	XC1	CF1	TK1	LC1	CN1	LW1	LH1	CB1	EP1	CT1		XC20	CF20	TK20	LC20	CN20	LW20	LH20	CB20	EP20	CT20	CM1			
Obj: PNV																								0.232	
CB1	486.1	-2383.5	-1129	-840	386.75	60	-60																		>= 0
L1	1	1	1	1	1																				<= 8
LP1	12.5	35	48	34.2	10.42	1	-1																		<= 120
LM1	5.3	10.2	11	13	5.3	1																			<= 600
CM1		2383.5	1129	840				1	-1																>= 0
EX1								1	-1	-1															>= 8500
CM1	486.1	-2383.5	-1129	-840	386.75	60	-60															-0.2014			>= 0
CB20												486.1	-2383.5	-1129	-840	386.75	60	-60						-1	>= 0
L20												1	1	1	1	1									<= 8
LP20												12.5	35	48	34.2	10.42	1	-1							<= 150
LM20												5.3	10.2	11	13	5.3	1								<= 700
CR20													2383.5	1129	840					-1					>= 0
EX20																			1	-1	-1				>= 9000
CM20												486.1	-2383.5	-1129	-840	386.75	60	-60						-0.2014	>= 0

*) The actual size of matrix is 140 × 220

XC = Rice cultivated activity
CF = Coffee cultivated activity
TX = Tea cultivated activity
LC = Lychee cultivated activity
CN = Corn cultivated activity
LW = Labor wage activity
LH = Labor hired activity
CB = Credit borrowing activity
EP = Expenditure activity
CT = Capital transfer activity
ACT = Activities

GM = Gross income
CB = Gross income balance
L = Land constraint
LP = Labor availability during peak season
LM = Labor availability during off-season
CM = Credit row
EX = Expenditure equation (constraint)
CM = Cash money balance
RHS = Right Hand Side
PNV = Present net value of income
OBJ = Objective function

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The serial runs of the Multi-period Linear Programming Model for 18 groups of farmers show the following solutions. In general, the dominant crop suggested by the model is lychee as mono-crop for all groups (Table 11) even though the productivity of lychee is lower than the acceptable yield. The acceptable yield of lychee is 600 to 700 kg/rai/year (Souco and Menini, 1989) and the average yield in Chiang Mai province is 630 kg/rai/year in crop year 1987/1988 (Deomampo and Jantakad, 1990) while in this model, the highest productivity of lychee was about 503 kg/rai/year when the tree reached 20 years old.

Table 11. Production plans for the first five years (rai)

Group No	Rice				Lychee				
	year				year				
	1	2	3	4	1	2	3	4	5
2	–	–	–	–	2.00	–	–	–	–
3	–	–	–	–	3.00	–	–	–	–
4	–	–	–	–	4.00	–	–	–	–
5	1.60	0.37	0.37	–	2.16	2.47	–	0.37	–
6	–	–	–	–	3.35	2.65	–	–	–
7	–	–	–	–	3.57	3.43	–	–	–
8	–	–	–	–	3.87	4.03	0.10	–	–
9	–	–	–	–	3.33	2.54	2.39	0.74	–
10	–	–	–	–	4.98	2.73	2.29	–	–
11	–	–	–	0.57	3.47	2.53	2.39	2.04	0.57
13	–	–	–	–	5.94	3.15	3.91	–	–
14	–	–	–	–	7.42	5.19	1.39	–	–
16	–	–	–	–	9.57	6.43	–	–	–
17	–	–	–	–	7.16	3.97	3.00	2.82	0.05
18	–	–	–	–	11.34	6.33	0.33	–	–
19	–	–	–	–	7.12	3.86	5.14	2.88	–
20	–	–	–	–	9.29	5.07	4.63	1.01	–
22	–	–	–	–	6.71	3.95	6.32	4.79	0.23

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Apart from this, the price of lychee used in this model is below the 1986-1988 average farm gate price of 41.00 baht/kg as reported by Agricultural Economic Statistic of Thailand (Deomampo and Jantakad, 1990).

Groups 5 and 11 (8 farms) should grow rice. These groups include rice in their plans since their wage labor income are low , less than 20,000 baht/year during the first five years (Table 12), which limits the capability of farmers in lychee investment and rice is more profitable than other crops in this situation. They also have to manage their wage income at the same time for consumption needs and investment of lychee during that time in order to optimize their net present value of income (NPVI) for the whole planning horizon. The IOP is made upon the assumption that the farmers are willing to be employed during off-season as demanded.

These farm plans are quite different from the present situation that only 20 farmers or 30.30 percent of total farmers grow lychee. However, this figure indicates that farmers have good response in adoption of lychee since this crop has just been introduced to them.

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Table 12.   Wage income for each group for
              the first five years.

Group No	Income (baht)				
	year				
	1	2	3	4	5
2	25164	25174	25738	29395	29395
3	40788	39902	40748	40889	41017
4	30144	28963	30091	30278	39953
5	19196	17020	16897	19404	19005
6	29467	26400	30120	31037	31304
7	23340	22681	24360	25505	28192
8	21960	25956	29563	27073	27453
9	21606	21820	20142	20880	20400
10	23460	20495	21660	22040	21825
11	18679	19678	17047	15449	17320
13	22693	21904	25680	25691	28382
14	27476	31927	31405	32807	33758
16	44963	33344	30662	21020	21729
17	22931	21520	20726	22994	19494
18	39804	31522	32554	43183	44056
19	27714	22600	31341	29008	39580
20	35519	28823	26693	26045	27689
22	28033	22976	30656	26479	27131

Actually, the farmers adopted coffee under supervision of various agencies when the price was rather high (at 80 baht/kg). In the optimal plans , coffee is not included because of its low price and yield (in the past four years, its price declined from 75.00 baht/kg to 42.00 baht/kg). According to Op de Laak (1986), the reasonable and possible but not the potential yield of coffee, should be around 100 kg/rai. In the study area, the highest yield was only 62.50 kg/rai when the tree reached seven years old.

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Like coffee, the production of tea in this area is very low. The maximum yield reached only 320 kg/rai of fresh leaves in year nine while TA-HASDP (1988) stated that with the low input, the yield of tea could be 600 kg fresh leaves/rai after year five. According to Maneewong of Cha Siam Tea Estate (personal communication, 1991), the price of tea increased quite slowly during the last 10 years with 4.00 baht/kg in 1981 to 7.00 baht/kg at present time. With the prevailing price of rice and corn (5.00 baht/kg and 2.50 baht/kg), both rice and corn are not attractive enough to be included in the plans for all farmers except those in groups 5 and 11 should grow rice as mentioned earlier.

The farmers in all groups should start to grow lychee in the first year and each group has its own planting schedule. The planting schedules are made depending on the availability of fund each year. The maximum time that the farmers can spread their planting is five years (groups 11 and 22). Groups 2, 3 and 4 can devote their land for lychee in the first year since they have enough money left from wage income after deducted by expenditure cost and because of their farms are very small.

In these optimal plans, the wage income plays a critical role in generating income before and after lychee can be harvested. It can be seen that farmers have no need to borrow credit from the bank for farm investment and family expenditure. Most of them can gain more than 40 percent of

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their total income from wage income.

It is too lengthy to present the yearly activities in detail for each group of farmers. Table 13 shows only the summary of total income, family expenditure, and total net present value of income occurring in 20 years of each group.

Wage income for farmers who have less than ten rai is higher than income from the farm, but in the other groups, farm income is higher than wage income except group 11. This is due to the amount of family labor available and relations to farm size which varies from farm to other farm.

Table 13. Total net present value of income, nominal income, expenditure, and cash money at the end of plans.

Group No	NPVI (baht)	Income (baht)			Expenditure (baht)	Cash money at the end of planning (baht)	Labor hired (baht)	
		Wage labor	Farm	Total				
		(a)					(b)	
2	355291	10534	632040 (86.61)	97747 (13.39)	729787	548088 (75.10)	181699 (24.90)	-	
3	445739	12123	727380 (83.22)	146680 (16.78)	874060	623202 (71.30)	250858 (28.70)	-	
4	457241	12534	752040 (79.37)	195517 (20.63)	947557	656866 (69.32)	290691 (30.68)	-	
5	415509	11237	674220 (74.62)	229260 (25.38)	903480	662230 (73.30)	241250 (26.70)	-	-
6	416733	10012	600720 (68.12)	281143 (31.88)	881863	595915 (67.57)	285948 (32.43)	-	-
7	409286	9673	580380 (64.03)	326016 (35.97)	906396	639372 (70.54)	267024 (29.46)	8	480
8	439825	10165	609900 (62.28)	369456 (37.72)	979356	739350 (75.49)	240006 (24.51)	39	2340
9	384591	8274	496440 (55.64)	395756 (44.36)	892196	584190 (65.48)	308006 (34.52)	20	1200
10	334402	6106	366360 (44.85)	450522 (55.15)	816882	492092 (60.24)	324790 (39.76)	87	5220
11	386928	8179	490740 (51.28)	466297 (48.72)	957037	482190 (50.38)	474847 (49.62)	25	1500
13	482027	8911	534660 (47.93)	580799 (52.07)	1115459	618302 (55.43)	497157 (44.57)	83	4980
14	558808	10195	611700 (48.81)	641642 (51.19)	1253342	851700 (67.95)	401642 (32.05)	108	6480
16	566037	9189	551340 (42.37)	749904 (57.63)	1301244	888708 (68.30)	412536 (31.70)	46	2760
17	528720	9527	571620 (43.93)	729654 (56.07)	1301274	595482 (45.76)	705792 (54.24)	145	8700
18	635759	9919	595140 (41.50)	839055 (58.50)	1434195	1009683 (70.40)	424512 (29.60)	148	8880
19	618356	10157	609420 (42.62)	820484 (57.38)	1429904	839296 (58.70)	590608 (41.30)	98	5880
20	591816	8301	498060 (35.85)	891177 (64.15)	1389237	865825 (62.32)	523412 (37.68)	135	8100
22	589651	8175	490500 (34.65)	924998 (65.35)	1415498	770942 (54.46)	644556 (45.54)	126	7560

Note : Values in parentheses are percentage of total income
Columns (a) and (b) are number of mandays
NPVI = net present value of income

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The farmers in all groups spend more than 50 percent of their income in consumption except farmers who have 17 rai (only 45.76 percent), so at the end of the planning horizon all farmers still have money left or saving. Since the model already incorporates expenditure equation, the farmers will spend at the level of basic needs when farmers have no income.

The group of farmers who have land more than six rai need to hire labor during the peak season for the first and second years because of the lack of labor for land preparation and planting lychee and/or rice. This opens another wage earning opportunity for smaller farmers in the village.

IV.2 Sensitivity Analysis

The purpose of sensitivity is to determine the alternative plans when economic environment and other conditions change. Furthermore, it provides insight role or significance of economic and environment factors. In addition, it can verify validity of the model. This analysis covers various changes in crop prices, wage rate, credit interest rate, discounted factor of net present value of income, labor demand, and allocation of land for rice consumption.

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IV.2.1 Changes in the price of rice

Three levels of rice prices (5.50, 6.00 and 6.50 baht/kg) were used to determine the alternative plans. These changes bring about the changes in expenditure equation since rice is one important component in food needs included in the estimation of expenditure equation. The result of expenditure equations estimated can be written as follows :

Table 14.　Estimation of expenditure equation at rice prices 5.50, 6.00 and 6.50 baht/kg

Price level (baht/kg)	Constant	FS	ADEQ	INC	R^2	Significant level
5.50	296.21	39.10	3222.41	0.1892	0.7550	1 percent
6.00	296.21	39.10	3282.63	0.1770	0.7459	1 percent
6.50	296.21	39.10	3342.86	0.1649	0.7366	1 percent

When price increases from 5.00 baht/kg to 5.50 baht/kg, only the farmers in groups 5, 9 and 11 should grow rice (Table 15), but the others remain the same as in the IOP solution. Farmers in these groups include rice in their plans since rice become more attractive for them than other crops even though they grow only in small part of their land in year three (1.06 rai). Farmers in groups 5 and 11 slightly change their cropping pattern by increasing rice cultivated area (replacing lychee area). Until the price reaches 6.50 baht, no additional group grows rice. At this price level, they

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slightly change their cropping pattern where lychee is still

the dominant crop in the long term.

Table 15. The summary effects of changes in price of rice on cropping patterns of groups 5, 9 and 11

Group No.	Rice	Corn	Maximum rai planted		
			Coffee	Tea	Lychee
Group 5					
IOP	v	–	–	–	5.00
price = 5.50 baht/kg	v	–	–	–	5.00
price = 6.00 baht/kg	v	–	–	–	5.00
price = 6.50 baht/kg	v	–	–	–	5.00
Group 9					
IOP	–	–	–	–	9.00
price = 5.50 baht/kg	v	–	–	–	9.00
price = 6.00 baht/kg	v	–	–	–	9.00
price = 6.50 baht/kg	v	–	–	–	9.00
Group 11					
IOP	v	–	–	–	11.00
price = 5.50 baht/kg	v	–	–	–	11.00
price = 6.00 baht/kg	v	–	–	–	11.00
price = 6.50 baht/kg	v	–	–	–	11.00

Note : v = farmers grow this crop
original price = 5.00 baht/kg

These changes also bring slight increases in NPVI

for those groups while the others still remain the same as in

the IOP. The maximum increase in NPVI is only 1.33 percent

from IOP (group 9) at price level 6.50 baht/kg when they can

increase their farm income and wage income which means that

they re-allocate labor utilization between farm activities and

wage labor earning activities (Table 16).

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Table 16.　The summary effects of changes in price of rice on NPVI, farm and wage income, expenditure and cash money of groups 5, 9 and 11 (baht)

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 5	(415509)	(229260)	(674220)	(662230)	(341250)
price = 5.50 baht/kg	416554	229312	674220	546487	357045
price = 6.00 baht/kg	418534	230524	674460	534237	370747
price ≈ 6.50 baht/kg	418986	233736	674700	585236	323200
Group 9	(384591)	(395756)	(496440)	(584190)	(308006)
price = 5.50 baht/kg	386480	395447	496560	572675	319034
price = 6.00 baht/kg	388102	496800	496800	569923	323081
price = 6.50 baht/kg	387923	497280	497280	563851	344446
Group 11	(386928)	(466297)	(490740)	(482190)	(474847)
price = 5.50 baht/kg	386928	466297	490740	468156	488881
price = 6.00 baht/kg	386928	466297	490740	459664	497373
price = 6.50 baht/kg	389047	473545	491820	459664	505701

Note : Values in parentheses are Initial Optimal Plan (IOP)
　　　 original price = 5.00 baht/kg

Most of the groups reduce their expenditure even if the price of rice increased. It can be explained that the price increases only cause increase in basic need expenses which is smaller than the decrease in other expenditures which is determined by the coefficient of income (INC) in the expenditure equation. The change in cash money at the end of the plan is difficult to be determined because it depends on how far the expenditure decreased, but most of them increase their cash money.

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IV.2.2   Changes in the price of corn

The effects of increasing the price of corn at three levels (3.00, 3.50 and 4.00 baht/kg) are presented as follows. When the price of corn increases to 3.00 baht/kg, groups 5, 9 and 11 or 12 farmers (18.18 percent) should add corn into their farm activities besides lychee (Table 17)

Table 17.   The summary effects of changes in price of corn on cropping patterns of groups 5, 9 and 11

Group No.	Rice	Corn	Maximum rai planted		
			Coffee	Tea	Lychee
Group 5					
IOP	v	–	–	–	5.00
price = 3.00 baht/kg	–	v	–	–	5.00
price = 3.50 baht/kg	–	v	–	–	5.00
price = 4.00 baht/kg	–	v	–	–	5.00
Group 9					
IOP	–	–	–	–	9.00
price = 3.00 baht/kg	–	v	–	–	9.00
price = 3.50 baht/kg	–	v	–	–	9.00
price = 4.00 baht/kg	–	v	–	–	9.00
Group 11					
IOP	v	–	–	–	11.00
price = 3.00 baht/kg	–	v	–	–	11.00
price = 3.50 baht/kg	–	v	–	–	11.00
price = 4.00 baht/kg	–	v	–	–	11.00

Note: original price = 2.50 baht/kg

Corn becomes attractive for these farmers since it is more profitable than rice when the farmers are capital constraint in lychee investment during the first five years of plan. The remaining groups have the same cropping pattern as in the IOP. Land allocated for lychee is not so different

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with the IOP for those groups. Further increase in price up to 4.00 baht/kg, the price effect on land allocation is just the same as when then corn price is 3.00 baht/kg.

As a consequence of land re-allocation or changing cropping patterns, the farmers in those 3 groups are expected to raise their NPVI. However, the increase is negligible (Table 18). The highest percentage of increase in NPVI can be reached at 0.38 percent by group 11 when the price of corn is 4.00 baht/kg. This is resulted by a slight increase in farm income which is partly offset by a decrease in wage income.

Table 18. The summary effects of changes in price of corn on NPVI, farm and wage income, expenditure and cash money of groups 5, 9 and 11 (baht)

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 5	(415509)	(229260)	(674220)	(662230)	(241250)
price = 3.00 baht/kg	415786	229939	674040	677259	226720
price = 3.50 baht/kg	416338	231004	673920	677479	227445
price = 4.00 baht/kg	416761	231896	673800	680051	225645
Group 9	(384591)	(395756	(496440)	(584190)	(308006)
price = 3.00 baht/kg	384602	396100	496140	597797	294443
price = 3.50 baht/kg	384759	396494	496080	613587	278988
price = 4.00 baht/kg	385390	396495	494640	629253	264723
Group 11	(386928)	(466297)	(490740)	(482190)	(474847)
price = 3.00 baht/kg	386973	481255	490740	597425	373570
price = 3.50 baht/kg	387517	499659	489120	615175	374604
price = 4.00 baht/kg	388404	502165	488340	628254	362251

Note: Values in parentheses are Initial Optimal Plan (IOP)
original price = 2.50 baht/kg

As a result of increase in total income for these groups, they also spend more money for expenditure and reduce their cash money at the end of the plans, especially group 11 which change significantly both in the increase in expenditure and the decrease in cash money (more than 20 percent).

IV.2.3 Changes in the price of tea

In this study, only price changes were used in the analysis since average yield is relatively more stable than average price. Increasing tea price from 7 to 8, 9 and 10 baht/kg do not alter the solution in the IOP. In other words tea is not profitable until price is 10 baht/kg. Based on the trend of increasing tea price, there is low probability that the price of tea will reach 10 baht/kg at the present time. The solution with this price is provided to show the threshold of price that tea can be included in the plan.

When the price increases to 11 baht/kg, 3 groups of farmers (11, 19 and 22) should grow tea beside lychee in their farm plans (Table 19). They re-allocate land from lychee in the IOP to grow tea. Among these groups, group 11 should also grow rice, so they have three crops in their plans (rice, lychee and tea).

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Table 19.   Summary effects of change in price of
             tea on cropping pattern of groups 11,
             19 and 22

Group			Maximum rai planted		
No.	Rice	Corn	Coffee	Tea	Lychee
Group 11					
IOP	v	-	-	-	11.00
price = 11.00 baht/kg	v	-	-	2.10	8.90
Group 19					
IOP	-	-	-	-	19.00
price = 11.00 baht/kg	-	-	-	2.89	16.11
Group 22					
IOP	-	-	-	-	22.00
price = 11.00 baht/kg	-	-	-	6.20	15.80

Note: original price = 7.00 baht/kg

        With the tea price 11.00 baht/kg, the highest
increase in NPVI is 0.22 percent for group 11 (Table 20).
These groups increase their expenditure and decrease cash
money at the end of plan.   Group 11 could be noted that they
increase expenditure and decrease cash money around 16.44
and 16.30 percent.   This outcome shows that the total income
increases substantially enough to raise farmer's spending on
consumption and it means that farmer can gain better living
condition.

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Table 20. The summary effects of change in price of tea on NPVI, farm and wage income, expenditure and cash money of groups 11, 19 and 22 (baht)

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 11	(386928)	(466297)	(490740)	(482190)	(474847)
price= 11.00 baht/kg	387785	475340	483120	561484	396976
Group 19	(618356)	(820484)	(609420)	(839296)	(590608)
price= 11.00 baht/kg	619274	839666	599760	862839	576587
Group 22	(589651)	(924998)	(490500)	(770942)	(644556)
price= 11.00 baht/kg	590517	955788	472440	837554	590674

Note: Values in parentheses are Initial Optimal Plan (IOP) original price = 7.00 baht/kg

IV.2.4 Changes in the price of coffee

Coffee is one of the most important crops in the study area (about 52 out of 66 farmers grow it), but does not appear in the IOP for all groups since its relatively price and yield are quite low in the study area. In this sensitivity analysis, like tea, only changes in price of coffee in the IOP are presented.

Increasing coffee prices from 42.00 baht/kg to 45.00 and 50.00 baht/kg make the optimum solutions for all groups to remain the same as in the IOP solution in which coffee was not included in their plans. After price increasing to 55.00 baht/kg, some groups such as groups 11, 17, 19 and 22 start to grow coffee beside lychee (Table 21). Additional price 5.00 baht/kg or when the price becomes 60.00 baht, all farmers turn

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totally from lychee to coffee. Coffee then replaces all
lychee area. Only groups 5 and 11 should grow rice beside
coffee.

Table 21. Summary effects of changes in price
of coffee on cropping pattern of all
groups

Group No.	Rice	Corn	Maximum rai planted		
			Coffee	Tea	Lychee
Group 2					
IOP	–	–	–	–	2.00
price = 60.00 baht/kg	–	–	2.00	–	–
Group 3					
IOP	–	–	–	–	3.00
price = 60.00 baht/kg	–	–	3.00	–	–
Group 4					
IOP	–	–	–	–	4.00
price = 60.00 baht/kg	–	–	4.00	–	–
Group 5					
IOP	v	–	–	–	5.00
price = 60.00 baht/kg	v	–	5.00	–	–
Group 6					
IOP	–	–	–	–	6.00
price = 60.00 baht/kg	–	–	6.00	–	–
Group 7					
IOP	–	–	–	–	7.00
price = 60.00 baht/kg	–	–	7.00	–	–
Group 8					
IOP	–	–	–	–	8.00
price = 60.00 baht/kg	–	–	8.00	–	–
Group 9					
IOP	–	–	–	–	9.00
price = 60.00 baht/kg	–	–	9.00	–	–
Group 10					
IOP	–	–	–	–	10.00
price = 60.00 baht/kg	–	–	10.00	–	–
Group 11					
IOP	v	–	–	–	11.00
price = 55.00 baht/kg	v	–	1.80	–	9.20
price = 60.00 baht/kg	–	–	11.00	–	–
Group 13					
IOP	–	–	–	–	13.00
price = 60.00 baht/kg	–	–	13.00	–	–

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Table 21. Continued

| Group No. | Rice | Corn | Maximum rai planted | | |
			Coffee	Tea	Lychee
Group 14					
IOP	–	–	–	–	14.00
price = 60.00 baht/kg	–	–	14.00	–	–
Group 16					
IOP	–	–	–	–	16.00
price = 60.00 baht/kg	–	–	16.00	–	–
Group 17					
IOP	–	–	–	–	17.00
price = 55.00 baht/kg	–	–	3.30	–	13.70
price = 60.00 baht/kg	–	–	17.00	–	–
Group 18					
IOP	–	–	–	–	18.00
price = 60.00 baht/kg	–	–	18.00	–	–
Group 19					
IOP	–	–	–	–	19.00
price = 55.00 baht/kg	–	–	2.90	–	16.10
price = 60.00 baht/kg	–	–	19.00	–	–
Group 20					
IOP	–	–	–		20.00
price = 60.00 baht/kg	–	–	20.00	–	–
Group 22					
IOP	–	–	–	–	22.00
price = 55.00 baht/kg	v	–	5.60	–	16.40
price = 60.00 baht/kg	–	–	22.00	–	–

Note: original price = 42.00 baht/kg

The farmers who change their cropping patterns can hardly improve their NPVI. The highest increment of NPVI are 0.39 and 4.16 percent (group 22) when the prices are 55.00 and 60.00 baht/kg, respectively (Table 22).

Farm income is improved for all farmers. The 7.59 percent maximum increment and 1.57 percent minimum increment are found in groups 17 and 19 respectively at price level of 55.00 baht/kg. When the price is 60.00 baht, the maximum and minimum increments of farm income become 13.81 and 5.18

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percent in groups 18 and 10, respectively. Most of them switch their labor from wage labor activity to farm activities which causes the reduction in wage income.

Table 22. The summary effects of changes in price of coffee on NPVI, farm and wage income, expenditure and cash money of selected groups (baht)

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 6	(416733)	(281143)	(600720)	(595915)	(285948)
price= 60.00 baht/kg	421722	305436	585900	604197	287139
Group 7	(409286)	(326016)	(580380)	(639372)	(267024)
price= 60.00 baht/kg	415142	364694	563460	654398	273756
Group 10	(334402)	(450522)	(366360)	(492092)	(324790)
price= 60.00 baht/kg	343030	473863	344580	517248	301195
Group 11	(386928)	(466297)	(490740)	(482190)	(474847)
price= 55.00 baht/kg	388289	484667	484020	601829	366858
price= 60.00 baht/kg	399693	496853	463020	660538	299335
Group 17	(528720)	(729654)	(571620)	(595482)	(705792)
price= 55.00 baht/kg	529721	785052	562920	676342	691630
price= 60.00 baht/kg	543867	826069	533460	724618	664911
Group 18	(635759)	(839055)	(595140)	(1009683)	(424512)
price= 60.00 baht/kg	651080	954954	577200	1042689	489465
Group 19	(618356)	(820484)	(609420)	(839296)	(590608)
price= 55.00 baht/kg	619655	833380	600660	874763	559304
price= 60.00 baht/kg	638077	866779	565620	930612	501787
Group 22	(589651)	(924998)	(490500)	(770942)	(644556)
price= 55.00 baht/kg	591972	954805	473820	960030	468595
price= 60.00 baht/kg	614208	980421	440040	1002360	418101

Note: Values in parentheses are Initial Optimal Plan (IOP)
original price = 42.00 baht/kg

The further effects of increasing price of coffee are increasing expenditure and reducing cash money at the end

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of the plans. Groups 6 and 7 increase both expenditure and cash money.

Groups 11 and 22 increase expenditure and reduce cash money significantly which are more than 20 percent when the price is 55.00 baht/kg and more than 30 percent when the price is 60.00 baht/kg.

IV.2.5 Changes in price of lychee

From initial optimal solution, it is clear that lychee is the most important crop in farm plans. In this sensitivity analysis, increasing its price from 10.00 baht/kg to 12.50 and 15.00 baht/kg are used to explore the impact on IOP. After running this sensitivity analysis, it is found that only four groups (5, 6, 7 and 16) change their cropping pattern by increasing number of rai at the first year of lychee investment. Besides, when the price of lychee is 15.00 baht/kg, all farmers grow only lychee in their plans.

NPVI for all groups increase insignificantly at price level of 12.50 baht/kg, ranging from 3.08 (group 2) to 16.97 percent (group 22) from the IOP (Table 23). When price reaches 15 baht/kg, those farmers who have land more than 8 rai can improve their NPVI significantly (more than 20.00 percent).

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Table 23. The summary effects of changes in price of lychee on NPVI, farm and wage income, expenditure and cash money of all groups (baht)

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 2	(355291)	(97747)	(632040)	(548088)	(181699)
price= 12.50 baht/kg	366231	125872	632040	577812	180100
price= 15.00 baht/kg	377172	153977	632040	596057	189960
Group 3	(445739)	(146680)	(727380)	(623202)	(250858)
price= 12.50 baht/kg	462150	188868	727380	652066	248182
price= 15.00 baht/kg	478561	231136	727380	687932	256584
Group 4	(457241)	(195517)	(752040)	(656866)	(290691)
price= 12.50 baht/kg	479123	251767	752040	725860	277947
price= 15.00 baht/kg	501003	308018	752040	759852	300206
Group 5	(415509)	(229260)	(674220)	(662230)	(241250)
price= 12.50 baht/kg	440576	295057	674460	735749	233768
price= 15.00 baht/kg	466380	365837	673680	751386	288131
Group 6	(416733)	(281143)	(600720)	(595915)	(285948)
price= 12.50 baht/kg	448015	372275	598140	705111	265304
price= 15.00 baht/kg	480836	456651	598140	747713	307078
Group 7	(409286)	(326016)	(580380)	(639372)	(267024)
price= 12.50 baht/kg	445438	442235	578640	756512	264363
price= 15.00 baht/kg	482651	533980	578640	770594	342026
Group 8	(439825)	(369456)	(609900)	(739350)	(240006)
price= 12.50 baht/kg	480748	476966	609840	854163	232643
price= 15.00 baht/kg	521728	584277	609840	875813	318304
Group 9	(384591)	(395756)	(496440)	(584190)	(308006)
price= 12.50 baht/kg	427668	510523	496440	700916	306047
price= 15.00 baht/kg	470848	626470	496440	744985	377625
Group 10	(334402)	(450522)	(366360)	(492092)	(324790)
price= 12.50 baht/kg	384321	582671	366360	607947	310904
price= 15.00 baht/kg	434334	714405	366360	640995	439590
Group 11	(386928)	(466297)	(490740)	(482190)	(474847)
price= 12.50 baht/kg	437220	601958	490740	623940	468638
price= 15.00 baht/kg	488013	741758	490740	684361	547117

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Table 23.   Continued

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 13	(482027)	(580799)	(534660)	(618302)	(497157)
price= 12.50 baht/kg	545981	751212	534660	791496	494076
price= 15.00 baht/kg	610134	920711	534660	841689	613442
Group 14	(558808)	(641642)	(611700)	(851700)	(401642)
price= 12.50 baht/kg	630149	833509	611700	984148	459801
price= 15.00 baht/kg	702296	1022173	611700	1030421	602132
Group 16	(566037)	(749904)	(551340)	(888708)	(412536)
price= 12.50 baht/kg	649611	982423	547380	1043361	486442
price= 15.00 baht/kg	735570	1204508	547490	1163201	588687
Group 17	(528720)	(729654)	(571620)	(595482)	(705792)
price= 12.50 baht/kg	609826	954765	571620	716699	809686
price= 15.00 baht/kg	690939	1171421	571620	841337	901524
Group 18	(635759)	(839055)	(595140)	(1009683)	(424512)
price= 12.50 baht/kg	729536	1084582	594840	1176291	503131
price= 15.00 baht/kg	823507	1329329	594840	1297874	666295
Group 19	(618356)	(820484)	(609420)	(839296)	(590608)
price= 12.50 baht/kg	707722	1059582	609420	934454	734548
price= 15.00 baht/kg	798122	1307420	609420	1250392	864648
Group 20	(591816)	(891177)	(498060)	(865825)	(523412)
price= 12.50 baht/kg	689968	1150986	498060	964331	684655
price= 15.00 baht/kg	788120	1410736	498060	1112292	796444
Group 22	(589651)	(924998)	(490500)	(770942)	(644556)
price= 12.50 baht/kg	689759	1195164	490500	928071	757593
price= 15.00 baht/kg	788779	1469214	490500	1062414	896400

Note: Values in parentheses are Initial Optimal Plan (IOP)
      original price = 10.00 baht/kg

Increment farm income is significant for all groups, around 30.00 percent when the price is 12.50 baht/kg and around 60.00 percent when the price is 15.00 baht/kg. The farmers who change the cropping pattern will earn less from

their wage income since they need to allocate more labor to support their farm activities.

As a result of increasing income when the price reaches 12.50 baht/kg, most of the farmers tend to spend more and thus their cash money reduces at the end of the plans. It can be explained that they use income increment for other items beside the basic needs since expenditure is also determined by income. When the price becomes 15.00 baht/kg, most of the farmers not only increase their expenditure but also increase their cash money at the end of the plan. The increases in expenditure and cash money are significant.

IV.2.6 Changes in wage rate

Two levels of wage rate (65.00 and 70.00 baht/manday) which are higher than the actual level (60.00 baht/manday) are used to observe the changes in the IOP. An increase in the wage rate allows farmers in most of groups to invest in lychee earlier than usual. The changes in re-scheduling are obvious since the farmers in most groups planted lychee in all their land in the first two years. Furthermore, the farmers in groups 5 and 11 can afford to replace lychee for rice.

All farmers can raise their NPVI slightly, ranging from 3.96 to 7.49 percent when the wage rate is 65.00 baht/manday. The NPVI rises between 7.84 and 14.98 percent when the wage rate is 70.00 baht/manday (Table 24). This is

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due mainly to an increase in wage income. The farm income is expected to increase only slightly since some more lychee trees can bear fruit a few years earlier. Consequently, the present value of income increases.

Table 24. The summary effects of changes in wage rate on NPVI, farm and wage income, expenditure and cash money of all groups (baht)

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 2	(355291)	(97747)	(632040)	(548088)	(181699)
wage=65.00 baht/manday	381908	97747	684710	593218	189236
wage=70.00 baht/manday	408525	97747	737380	63473	200387
Group 3	(445739)	(146680)	(727380)	(623202)	(250858)
wage=65.00 baht/manday	478398	146681	787995	667563	267113
wage=70.00 baht/manday	511056	146681	848610	699605	295686
Group 4	(457241)	(195517)	(752040)	(656866)	(290691)
wage=65.00 baht/manday	489364	195517	814710	704130	306094
wage=70.00 baht/manday	521486	195517	877380	755145	317749
Group 5	(415509)	(229260)	(674220)	(662230)	(241250)
wage=65.00 baht/manday	444632	234076	729820	704982	258914
wage=70.00 baht/manday	472336	240066	785960	744217	281809
Group 6	(416733)	(281143)	(600720)	(595915)	(285948)
wage=65.00 baht/manday	443001	281143	650780	613076	318847
wage=70.00 baht/manday	469268	281143	700840	646121	335862
Group 7	(409286)	(326016)	(580380)	(639372)	(267024)
wage=65.00 baht/manday	433587	326016	628745	644264	310497
wage=70.00 baht/manday	457887	326016	677110	685901	317225
Group 8	(439825)	(369456)	(609900)	(739350)	(240006)
wage=65.50 baht/manday	463365	369861	660595	746544	283912
wage=70.00 baht/manday	490835	369861	711410	799657	281614
Group 9	(384591)	(395756)	(496440)	(584190)	(308006)
wage=65.00 baht/manday	406152	405291	535145	611684	328752
wage=70.00 baht/manday	426194	408886	574980	642386	341480

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Table 24. Continued

Group No		NPVI	Farm income	Wage income	Expenditure	Cash money
Group 10		(334402)	(450522)	(366360)	(492092)	(324790)
wage=65.00	baht/manday	348992	451352	396565	511372	336545
wage=70.00	baht/manday	363290	452410	426580	533792	345198
Group 11		(386928)	(466297)	(490740)	(482190)	(474847)
wage=65.00	baht/manday	407382	478077	528580	502153	504504
wage=70.00	baht/manday	426372	485211	566930	535792	516349
Group 13		(482027)	(580799)	(534660)	(618302)	(497157)
wage=65.00	baht/manday	504943	582811	578500	653647	507664
wage=70.00	baht/manday	527628	584438	662300	682698	524040
Group 14		(558808)	(641642)	(611700)	(851700)	(401642)
wage=65.00	baht/manday	586116	643981	661830	879876	425935
wage=70.00	baht/manday	613150	645875	711900	929272	428503
Group 16		(566037)	(749904)	(551340)	(888708)	(412536)
wage=65.00	baht/manday	590522	749904	597285	900795	446394
wage=70.00	baht/manday	615006	749904	643230	937750	455384
Group 17		(528720)	(729654)	(571620)	(595482)	(705792)
wage=65.00	baht/manday	551339	744398	617370	644882	716886
wage=70.00	baht/manday	573487	747597	658980	667835	738742
Group 18		(635759)	(839055)	(595140)	(1009683)	(424512)
wage=65.00	baht/manday	663295	840572	644085	1050188	434469
wage=70.00	baht/manday	690594	840572	693630	1065188	469014
Group 19		(618356)	(820484)	(609420)	(839296)	(590608)
wage=65.00	baht/manday	646360	826770	658255	890112	594913
wage=70.00	baht/manday	673808	828346	708260	927608	608998
Group 20		(591816)	(891177)	(498060)	(865825)	(523412)
wage=65.00	baht/manday	615393	899825	536835	892593	544067
wage=70.00	baht/manday	638206	900357	577850	905279	572928
Group 22		(589651)	(924998)	(490500)	(770942)	(644556)
wage=65.00	baht/manday	613040	931383	529620	807408	653595
wage=70.00	baht/manday	635952	935278	569240	837704	666814

Note: Values in parentheses are Initial Optimal Plan (IOP)
original wage rate = 60.00 baht/manday

The NPVI of the farmers in groups 2, 3 and 4 are raised solely by the increases of wage rate since in the IOP he farmers in these groups plant lychee in all of their land in the first year.

Following increasing in total income, the expenditure and cash money also rise, but not significantly. The increase varies from farmer to farmer, it can be noted that the highest is 8.23 and 15.81 percent for expenditure, and 11.50 and 18.80 percent for cash money when wage rate equals 55.00 baht and 50.00 baht/manday, respectively.

IV.2.7 Changes in credit interest rate

Even though credit interest rate reduces from 14.50 percent to 12 percent/year, all farmers do not take this credit facility. This can happen since the farmers have enough saving to support their lychee investment and expenditure, while wage income contributes quite enough to total income.

IV.2.8 Changes in discounted rate

In the initial optimal plan, this study uses discounted factor at 8.00 percent/year. To know the effect of the change of this factor, three levels of discounted factor were used in this study ; 9.00 , 10.00 and 11.00 percent/year. Increasing discounted factor to 9.00 and 10.00 percent do not change cropping pattern for all groups. After increasing to

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11.00 percent, it was found that only two groups (8 and 14) change their cropping pattern by reducing the area for planting lychee in the first year after that increasing the area in the second and the third years.

   The direct impact of increasing this discounted factor for all groups is the reduction in NPVI but farm and wage income, expenditure and cash money at the end of plans do not change as long as they do not change the cropping pattern. After increasing to 11.00 percent, NPVI reduces significantly, ranging from 20.07 to 25.33 percent (Table 25).

Table 25. Summary effects of changes discounted factors on NPVI
     of all groups (baht)

Group No	Model			
			discounted factor :	
	IOP	9.00 percent	10.00 percent	11.00 percent
Group 2				
NPVI	355291	329737 (-7.19)	306977 (-13.60)	276733 (-22.11)
Group 3				
NPVI	445739	416274 (-6.61)	390260 (-12.45)	346962 (-22.16)
Group 4				
NPVI	457241	423716 (-7.33)	393853 (-13.86)	361313 (-21.98)
Group 5				
NPVI	415509	382609 (-7.92)	353386 (-14.95)	327550 (-21.17)
Group 6				
NPVI	416733	385327 (-7.54)	357729 (-14.16)	333075 (-20.07)
Group 7				
NPVI	409286	376076 (-8.11)	346894 (-15.24)	321039 (-21.56)
Group 8				
NPVI	439825	403732 (-8.20)	372888 (-15.21)	343900 (-21.81)*
Group 9				
NPVI	384591	350969 (-8.74)	321428 (-16.42)	295219 (-23.24)
Group 10				
NPVI	334402	303108 (-9.36)	275973 (-17.47)	252138 (-24.60)
Group 11				
NPVI	386928	350053 (-9.53)	318406 (-17.70)	290386 (-24.95)

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Table 25. Continued

Group No	Model			
	IOP	discounted factor :		
		9.00 percent	10.00 percent	11.00 percent
Group 13				
NPVI	482027	440080 (-8.70)	403311 (-16.33)	370813 (-23.07)
Group 14				
NPVI	558808	512359 (-8.31)	471359 (-15.60)	435696 (-22.03)*
Group 16				
NPVI	566037	517748 (-8.53)	475685 (-15.96)	438696 (-22.50)
Group 17				
NPVI	528720	477941 (-9.60)	433841 (-17.95)	394819 (-25.33)
Group 18				
NPVI	635759	582749 (-8.34)	536050 (-15.68)	495799 (-22.01)
Group 19				
NPVI	618356	564475 (-8.71)	517317 (-16.34)	475399 (-23.19)
Group 20				
NPVI	591816	539371 (-8.86)	493365 (-16.64)	453077 (-23.44)
Group 22				
NPVI	589651	535655 (-9.16)	489145 (-17.04)	447817 (-24.05)

Note: Values in parentheses are Initial Optimal Plan (IOP)
original wage rate = 60.00 baht/manday
* change cropping pattern

Groups 8 and 14, who change cropping pattern, farm income reduces but wage income increases slightly. Their expenditure decreases by 4.63 and 4.77 percent but cash money increases by 10.44 and 12.71 percent, respectively .

IV.2.9 Changes in labor wage demand

In reality not all labor left from farm activities can be absorbed by the CSTE and RTP or other opportunities. In this study, the sensitivity analysis with decreasing labor demand for all groups of farmers is used to examine this impact on the farm plan.

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The job opportunity to each individual is not equal. However, it is impossible to identify the individual opportunity and determine optimal plan for each group, besides, it is not the purpose of the study to investigate optimal plans for individuals. Therefore, equal opportunity is applied across all groups of farmers. This reflects in wage labor coefficients. The wage labor coefficient is increased from 1.00 to 1.25, 1.67, 2.50 and 5.00 (four levels) for all groups which means that the labor surplus from farm activities can get the job will be decreased from 100.00 percent to 80.00, 60.00, 40.00 and 20.00 percent of the initial level, respectively.

Table 26 shows that rice becomes important for some groups (9, 10, 17, 20 and 22) when the labor demand decreases to 80.00 percent.

Further reductions to 60.00 and 40 percent suggest all groups to grow rice. The reduction of labor demand automatically reduces the farmers' income which limits their capital availability in coffee and lychee investment. Then, rice is more profitable than any other crops in this condition.

Table 26. Summary effects of decreasing in labor demand to 80.00, 60.00 and 40.00 percent on cropping patterns (all groups)

Group No.		Rice	Corn	Maximum rai planted		
				Coffee	Tea	Lychee
Group 2						
IOP		–	–	–	–	2.00
labor demand = 80 %		–	–	–	–	2.00
labor demand = 60 %		v	–	–	–	2.00
labor demand = 40 %		v	–	–	–	2.00
Group 3						
IOP		–	–	–	–	3.00
labor demand = 80 %		–	–	–	–	3.00
labor demand = 60 %		v	–	–	–	3.00
labor demand = 40 %		v	–	–	–	3.00
Group 4						
IOP		–	–	–	–	4.00
labor demand = 80 %		–	–	–	–	4.00
labor demand = 60 %		v	–	–	–	4.00
labor demand = 40 %		v	–	–	–	4.00
Group 5						
IOP		v	–	–	–	5.00
labor demand = 80 %		–	–	–	–	5.00
labor demand = 60 %		v	–	–	–	5.00
labor demand = 40 %		i n f e a s i b l e				
Group 6						
IOP		–	–	–	–	6.00
labor demand = 80 %		–	–	–	–	6.00
labor demand = 60 %		v	–	–	–	6.00
labor demand = 40 %		v	–	1.33	–	4.67
Group 7						
IOP		–	–	–	–	7.00
labor demand = 80 %		–	–	–	–	7.00
labor demand = 60 %		v	–	–	–	7.00
labor demand = 40 %		v	–	2.05	–	4.95
Group 8						
IOP		–	–	–	–	8.00
labor demand = 80 %		–	–	–	–	8.00
labor demand = 60 %		v	–	–	–	8.00
labor demand = 40 %		v	–	0.11	–	7.89
Group 9						
IOP		–	–	–	–	9.00
labor demand = 80 %		v	–	–	–	9.00
labor demand = 60 %		v	–	–	–	9.00
labor demand = 40 %		v	–	4.59	–	4.41
Group 10						
IOP		–	–	–	–	10.00
labor demand = 80 %		v	–	–	–	10.00
labor demand = 60 %		v	–	0.94	–	9.06
labor demand = 40 %		v	–	2.47	–	7.53

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Table 26. Continued

Group No.	Rice	Corn	Coffee	Tea	Lychee
			Maximum rai planted		
Group 11					
IOP	v	–	–	–	11.00
labor demand = 80 %	v	–	–	–	11.00
labor demand = 60 %	v	–	–	–	11.00
labor demand = 40 %	v	–	5.37	–	5.63
Group 13					
IOP	–	–	–	–	13.00
labor demand = 80 %	–	–	–	–	13.00
labor demand = 60 %	v	–	–	–	13.00
labor demand = 40 %	v	–	1.19	–	11.81
Group 14					
IOP	–	–	–	–	14.00
labor demand = 80 %	–	–	–	–	14.00
labor demand = 60 %	v	–	–	–	14.00
labor demand = 40 %	v	–	–	–	14.00
Group 16					
IOP	–	–	–	–	16.00
labor demand = 80 %	–	–	–	–	16.00
labor demand = 60 %	v	–	–	–	16.00
labor demand = 40 %	v	–	1.37	–	14.63
Group 17					
IOP	–	–	–	–	17.00
labor demand = 80 %	v	–	–	–	17.00
labor demand = 60 %	v	–	–	–	17.00
labor demand = 40 %	v	–	1.36	–	15.64
Group 18					
IOP	–	–	–	–	18.00
labor demand = 80 %	–	–	–	–	18.00
labor demand = 60 %	v	–	–	–	18.00
labor demand = 40 %	v	–	1.50	–	16.50
Group 19					
IOP	–	–	–	–	19.00
labor demand = 80 %	–	–	–	–	19.00
labor demand = 60 %	v	–	–	–	19.00
labor demand = 40 %	v	–	1.20	–	17.80
Group 20					
IOP	–	–	–	–	20.00
labor demand = 80 %	v	–	–	–	20.00
labor demand = 60 %	v	–	–	–	20.00
labor demand = 40 %	v	–	5.55	–	14.45
Group 22					
IOP	–	–	–	–	22.00
labor demand = 80 %	v	–	–	–	22.00
labor demand = 60 %	v	–	–	–	22.00
labor demand = 40 %	v	–	8.68	–	13.32

Coffee should be included in farm plan in most the groups who have lands more than five rai when labor demand decrease to 40.00 percent even though in small area since coffee can generate income earlier than lychee to compensate reduction of income from wage labor. The farmers in group 5 is in an infeasible conditions when labor demand reduces to 40.00 percent since the wage income is quite low to afford basic needs at the first and the second years even though they grow rice in all their land.

They plant coffee in years 1, 2 and 8. Lychee is still included in the farm plan as a dominant crop , but they adjust cropping pattern by re-scheduling their lychee planting. When labor demand drops to 20.00 percent, all groups are in infeasible condition. This result highlights the important role of wage income in supporting the highland permanent systems.

The NPVI reduces significantly (more than 20.00 percent) as labor demand decreases to 60.00 and 40.00 percent (Table 27). The farm income also reduces step by step according to the decrease in labor demand since the farmers change their cropping patterns to satisfy all constraints. To all farmers both expenditure and cash money at the end of the plan also reduce as a result of the reduction of total income. Again, the more decrease in labor demand (or reduction in labor to work), the more reduction in both items for all groups.

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Table 27. The summary effects of changes in labor demand on NPVI, farm and wage income, expenditure and cash money of all groups (baht)

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 2					
labor demand= 60 %	(355291)	(97747)	(632040)	(548088)	(181699)
	227148	97824	378480	413691	62613
labor demand= 40 %	154843	73856	254220	277576	50500
Group 3					
labor demand= 60 %	(445739)	(146680)	(727380)	(623202)	(250858)
	288507	140679	435600	467774	108505
labor demand= 40 %	210595	135688	290940	343568	83060
Group 4					
labor demand= 60 %	(457241)	(195517)	(752040)	(656866)	(290691)
	302594	195552	450300	444732	201120
labor demand= 40 %	205826	139184	645852	351913	91651
Group 5					
labor demand= 60 %	(415509)	(229260)	(674220)	(662230)	(241250)
	244827	154947	408480	424453	138974
labor demand= 40 %	i n f e a s i b l e				
Group 6					
labor demand= 60 %	(416733)	(281143)	(600720)	(595915)	(285948)
	288820	276624	359940	434234	202330
labor demand= 40 %	203934	211868	242400	397436	56832
Group 7					
labor demand= 60 %	(409286)	(326016)	(580380)	(639372)	(267024)
	284890	305837	348840	446912	207765
labor demand= 40 %	195458	213354	236100	371299	78155
Group 8					
labor demand= 60 %	(439825)	(369456)	(609900)	(739350)	(240006)
	307577	339867	367980	505160	206287
labor demand= 40 %	209408	243409	250980	409160	85229
Group 9					
labor demand= 60 %	(384591)	(395756)	(496440)	(584190)	(308006)
	259829	309751	305040	379399	235392
labor demand= 40 %	167043	204119	614791	359548	46831
Group 10					
labor demand= 60 %	(334402)	(450522)	(366360)	(492092)	(324790)
	244494	385371	226140	402301	209210
labor demand= 40 %	178927	295560	152580	389962	58178
Group 11					
labor demand= 60 %	(386928)	(466297)	(490740)	(482190)	(474847)
	267441	368562	303600	423861	248301
labor demand= 40 %	175580	246000	194940	326615	114325

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Table 27. Continued

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 13	(482027)	(580799)	(534660)	(618302)	(497157)
labor demand= 60 %	355289	529393	325680	537475	317598
labor demand= 40 %	264852	427946	221520	527736	21730
Group 14	(558808)	(641642)	(611700)	(851700)	(401642)
labor demand= 60 %	415368	600494	371340	668316	303518
labor demand= 40 %	307817	488330	253860	547558	194632
Group 16	(566037)	(749904)	(551340)	(888708)	(412536)
labor demand= 60 %	426300	680320	396780	730998	346102
labor demand= 40 %	327369	567591	227940	563502	232029
Group 17	(528720)	(729654)	(571620)	(595482)	(705792)
labor demand= 60 %	395598	655968	352200	509377	498791
labor demand= 40 %	309545	568176	239700	465974	341902
Group 18	(635759)	(839055)	(595140)	(1009683)	(424512)
labor demand= 60 %	477222	755279	365220	801054	319445
labor demand= 40 %	360022	616435	249420	682249	183606
Group 19	(618356)	(820484)	(609420)	(839296)	(590608)
labor demand= 60 %	457377	730528	374220	796767	307981
labor demand= 40 %	339405	572838	258180	602236	228782
Group 20	(591816)	(891177)	(498060)	(865825)	(523412)
labor demand= 60 %	436978	751281	312120	714527	348874
labor demand= 40 %	310053	560909	213780	616944	157745
Group 22	(589651)	(924998)	(490500)	(770942)	(644556)
labor demand= 60 %	435470	780644	307800	708870	379594
labor demand= 40 %	316998	563778	209100	568641	204237

Note: Values in parentheses are Initial Optimal Plan (IOP) original labor demand= 100.00 percent

With these cropping plans (labor demand at 60.00 and 40.00 percent), the farmers in most groups need to borrow credit in the first few years since they have limiting fund for lychee investment. However, the amount of credit is

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rather small. It ranges from about 180 to 8900 baht (Table 28).

Table 28. Amount credit borrowed by certain groups at labor demand 60.00 and 40.00 percent.

Group No.	Amount of credit (baht)
Group 6	
labor demand = 40 %	1241.85
Group 7	
labor demand = 60 %	1495.31
labor demand = 40 %	1995.81
Group 8	
labor demand = 40 %	2328.00
Group 9	
labor demand = 60 %	928.32
labor demand = 40 %	4338.66
Group 10	
labor demand = 60 %	2248.46
labor demand = 40 %	5344.24
Group 11	
labor demand = 60 %	1120.27
labor demand = 40 %	8893.24
Group 13	
labor demand = 60 %	1323.83
labor demand = 40 %	5105.70
Group 14	
labor demand = 40 %	7831.60
Group 16	
labor demand = 40 %	184.69
labor demand = 60 %	5593.28
Group 17	
labor demand = 60 %	2788.53
labor demand = 40 %	4011.14
Group 18	
labor demand = 40 %	7456.67
Group 19	
labor demand = 60 %	2156.78
labor demand = 40 %	3029.57
Group 20	
labor demand = 60 %	5375.75
labor demand = 40 %	7905.41
Group 22	
labor demand = 60 %	8043.21
labor demand = 40 %	8846.95

These results show that it is quite reasonable to reduce labor demand to 60.00 and 40.00 percent since the two of tea companies can only absorb 40.00 percent from nearby villages.

IV.2.10. Minimum allocation of land for rice consumption

Rice is a dominant staple food in the study area. Twenty three out of 66 farmers (34.85 percent) are engaged in rice. Therefore, it is necessary to incorporate minimum rice land required for their consumption needs. Minimum rice land could be derived by calculating rice consumption for each group annually. One adult equivalent needs 120.45 kg/year (Sriboonchitta, 1988).

After serial runs for all groups, lychee is still the dominant crop, no other perennial crops should be grown (Table 29). They change cropping pattern by re-scheduling and reducing area for lychee because they have to allocate their land for rice.

Table 29. The summary effects of allocating minimum land for rice consumption on cropping patterns (all groups)

Group No.	Rice (rai)	Corn	Coffee	Tea	Lychee
			Maximum rai planted		
Group 2					
IOP	–	–	–	–	2.00
allocating land rice	2.00	–	–	–	–
Group 3					
IOP	–	–	–	–	3.00
allocating land rice	2.50	–	–	–	0.50
Group 4					
IOP	–	–	–	–	4.00
allocating land rice	3.00	–	–	–	1.00
Group 5					
IOP	v	–	–	–	5.00
allocating land rice	2.50	–	–	–	2.50
Group 6					
IOP	–	–	–	–	6.00
allocating land rice	2.50	–	–	–	3.50
Group 7					
IOP	–	–	–	–	7.00
allocating land rice	2.00	–	–	–	5.00
Group 8					
IOP	–	–	–	–	8.00
allocating land rice	2.50	–	–	–	5.50
Group 9					
IOP	–	–	–	–	9.00
allocating land rice	2.50	–	–	–	6.50
Group 10					
IOP	–	–	–	–	10.00
allocating land rice	2.50	–	–	–	7.50
Group 11					
IOP	v	–	–	–	11.00
allocating land rice	2.50	–	–	–	8.50
Group 13					
IOP	–	–	–	–	13.00
allocating land rice	3.00	–	–	–	10.00
Group 14					
IOP	–	–	–	–	14.00
allocating land rice	3.00	–	–	–	11.00
Group 16					
IOP	–	–	–	–	16.00
allocating land rice	2.50	–	–	–	13.50

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Table 29. Continued

Group No.	Rice (rai)	Corn	Coffee	Tea	Lychee
			Maximum rai planted		
Group 17					
IOP	-		-	-	
allocating land rice	2.50	-		-	17.00
Group 18			-	-	14.50
IOP	-				
allocating land rice	3.00	-	-	-	18.00
Group 19			-	-	15.00
IOP	-				
allocating land rice	3.50	-	-	-	19.00
Group 20			-	-	15.50
IOP	-				
allocating land rice	2.50	-	-	-	20.00
Group 22			-	-	17.50
IOP	-				
allocating land rice	3.50	-	-	-	22.00
		-	-	-	18.50

The effect of including rice requirement into the model does not show significant reduction in the NPVI. The maximum reduction in NPVI can be found only at 5.94 percent (group 9) and the minimum is 2.56 percent (group 17) from the IOP (Table 30).

However, farm income decreases drastically as farm size gets very small. The maximum decrease is 80.10 percent for farmers in group 2. Farm income is a minor income for them (only 13 percent of total income). Therefore, if farm income reduces slightly as a result of allocating all their land for rice for the whole planning period it will reduce significantly the percentage of income.

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On the other hand, all farmers in this group can increase wage income by only 3.15 percent (group 2) to 6.03 percent (group 10) from the IOP. Thus total income decreases.

Table 30. The summary effects of allocating minimum land for consumption on NPVI, farm and wage income, expenditure and cash money of all groups (baht)

Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 2 with land for rice	(355291) 340109	(97747) 19444	(632040) 651960	(548088) 515362	(181699) 156042
Group 3 with land for rice	(445739) 424093	(146680) 39258	(727380) 753840	(623202) 563565	(250858) 229533
Group 4 with land for rice	(457241) 434469	(195517) 78063	(752040) 781920	(656866) 591719	(290691) 268264
Group 5 with land for rice	(415509) 399286	(229260) 143446	(674220) 697080	(662230) 624398	(241250) 216128
Group 6 with land for rice	(416733) 400041	(281143) 190515	(600720) 624120	(595915) 536057	(285948) 278578
Group 7 with land for rice	(409286) 396103	(326016) 252917	(580380) 599340	(639372) 602254	(267024) 250003
Group 8 with land for rice	(439825) 423699	(369456) 277514	(609900) 633900	(739350) 681905	(240006) 229509
Group 9 with land for rice	(384591) 361742	(395756) 322168	(496440) 515760	(584190) 549445	(308006) 288483
Group 10 with land for rice	(334402) 319722	(450522) 366944	(366360) 388440	(492092) 464020	(324790) 291364
Group 11 with land for rice	(386928) 375791	(466297) 404532	(490740) 507540	(482190) 473234	(474847) 438838
Group 13 with land for rice	(482027) 464615	(580799) 482222	(534660) 560880	(618302) 601437	(497157) 441665

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Table 30. Continued

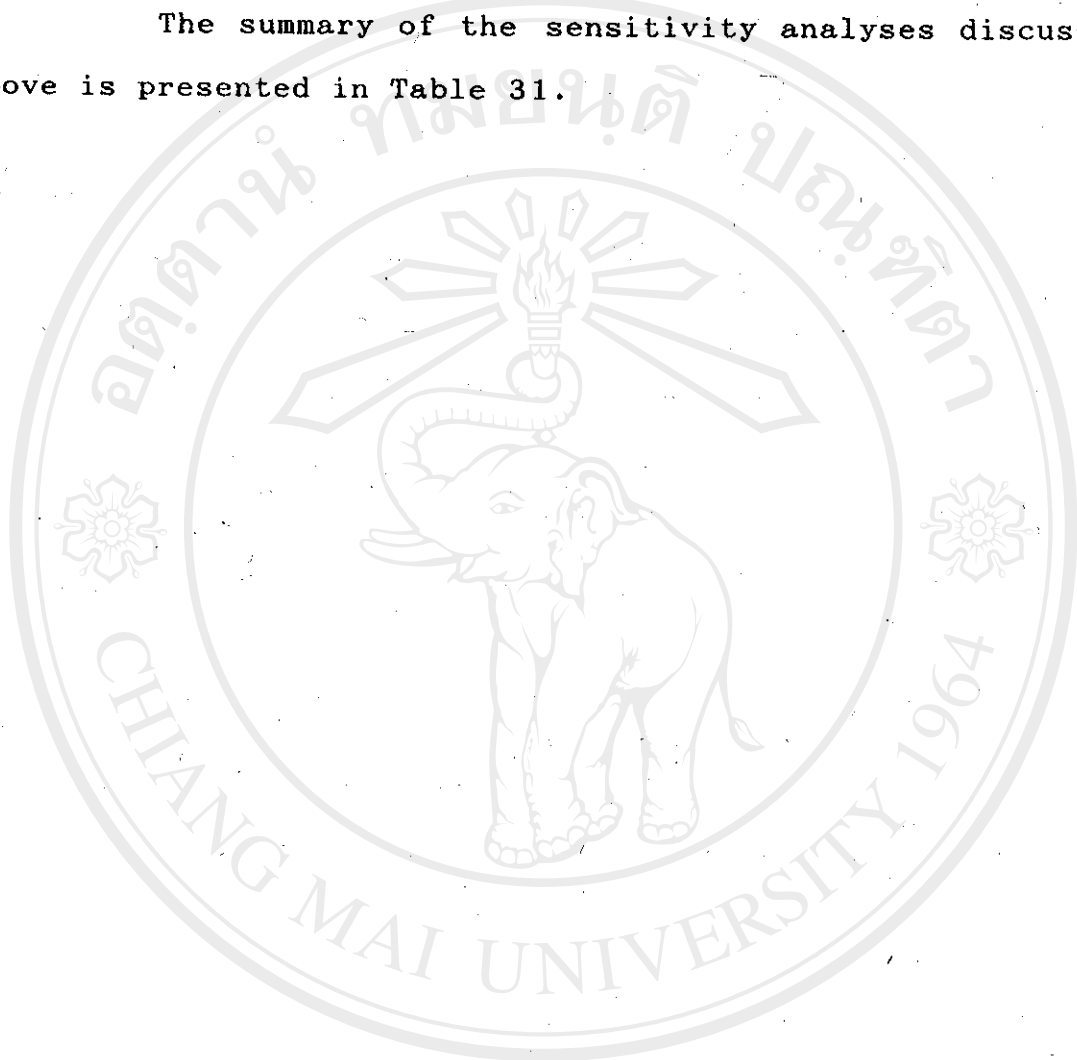| Group No	NPVI	Farm income	Wage income	Expenditure	Cash money
Group 14	(558808)	(641642)	(611700)	(851700)	(401642)
with land for rice	540651	540512	638160	784016	394656
Group 16	(566037)	(749904)	(551340)	(888708)	(412536)
with land for rice	548154	650649	576540	821063	406126
Group 17	(528720)	(729654)	(571620)	(595482)	(705792)
with land for rice	515189	663715	591540	588486	666769
Group 18	(635759)	(839055)	(595140	(1009683)	(424512)
with land for rice	614143	720540	625080	964291	381329
Group 19	(618356)	(820484)	(609420)	(839296)	(590608)
with land for rice	598785	712254	637980	816610	533624
Group 20	(591816)	(891177)	(498060)	(865825)	(523412)
with land for rice	573430	799100	520200	839192	480108
Group 22	(589651)	(924998)	(490500)	(770942)	(644556)
with land for rice	570967	825620	515700	742277	599043

Note: Values in parentheses are Initial Optimal Plan (IOP)

The expenditure and cash money at the end of the plans decrease as a result of decreasing total income. It can be noted that decreasing both of these variables are not significant (less than 20.00 percent from the IOP). The maximum is 10.04 percent for expenditure (group 4) and 14.12 percent for cash money at the end of plan (group 2).

From the explanation above, farmer are suggested to buy rice for their consumption rather than allocating their land for this staple food. Another factor to be considered also is that if rice constraint is to be imposed, farmers need

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to put a certain area aside especially for rice, and repeated mono-cropping rice tend to decrease yields every year even though rice cultural practices by farmers do not cause serious soil erosion (Worachai et al., 1989).

The summary of the sensitivity analyses discussed above is presented in Table 31.

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Table 31. The summary of the sensitivity analyses

Sensitivity	Cropping pattern	Farm income	Wage income	NPVI	Expenditure	Cash money
Rice (5 b/kg) 5.50, 6.00 & 6.50 b/kg	Group 9 also includes rice	+	+	+	- since only + BNS but other income	most of - them +
Corn (2.50 b/kg)) 3.00, 3.50 & 4.00 b/kg	Groups 5, 9 & 11 grow corn	+ total income +	- +	+	+ group 11 + signif	- +
Tea (7.00 b/kg) 11.00 B/kg	Groups 11,19 & 22 grow tea beside lychee	+ total income +	- +	+	+	-
Coffee (42.00 b/kg) 55.00 b/kg	Groups 11, 17, 19 & 22 grow coffee beside lychee	+	-	+	+	-
60.00 b/kg	Coffee completely replaces lychee for all groups.	+		+	+ Groups 6 and 7: + Groups 11 and 22: + signif	- Groups 6 and 7: - Groups 11 and 22: + signif
Lychee (10.00 b/kg) 15.00 b/kg	Only lychee in their plans.	+ signif	-	+ signif (more 8 rai)	+ signif	+ signif
Wage rate (60.00 b/manday) 65.00 & 70.00 b/manday	Planting lychee earlier (1st 2 years) Groups 5 and 11 replace lychee for rice	+	+	+	+	+

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Table 31. Continued

Sensitivity	Cropping pattern	Farm income	Wage income	NPVI	Expenditure	Cash money

Credit int. rate (14.50 %)
12.00 %   Not change, farmers do not take this credit facility

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Discounted factor (8.00 %)

11.00 %	Groups 8 and 14 reduce planting lychee area at the 1st year	not change as long as not change cropping pattern	not change	- signif direct impact	+ (Groups 8 and 14)	+

Labor wage demand

80 %	Groups 9, 10, 17, 20 & 22 grow rice	The more decrease in labor demand, the more decrease in farm income, wage income, expenditure and cash money				
60 %	All groups grow rice			- signif		
40 %	most of farmers who have land more than 5 rai include coffee beside lychee.			- signif		

Farmers in group 5 can not afford their basic needs (low wage income)or infeasible condition

60 and 40 %   Credit becomes important for some groups in this situation

20 %   all farmers are infeasible condition.

Allocation of land for rice consumption		- drastically as farm size get small	+	-	-	-

Note : Values in parentheses are original values in IOP
    + = increases
    - = decreases
    signif= significantly

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