CHAPTER V

POLICY ANALYSIS

An important and correct general strategy for sensitivity / policy analysis is the (a) "with minus without approach" and (b) changing the economic and technological constraints (Davis, 1992). In policy analysis farming system is evaluated with the discrete sets of additional constraints and so as proposed for a new policy and comparing the results to these found under current policy for the system "without" the new constraints. The basic optimum plan or current management practice is the best reference point to measure the effect of policy changes.

The purpose of the sensitivity analyses in this study is to determine the alternative plans when economic and policy environment changes, besides testing the validity and stability of the purposed model. It is also done here to take account of risk into the farm plan as it is fairly a rough and ready means of measuring risk (Timothy, 1991). Policy analysis in this study seems especially appropraite since farmers with different socioeconomic classes and resources, (such as in the hill of Nepal), have different goals, resource availabiltiy and resource constraints.

Mathematical programming facilitates decision making process by showing the consequences of series of policy goals encompassing the whole

activities of the farm systems. In view of the household's goals to maximize net present value of income (NPV) subject to various constraints imposed by scarce resources, complex inter-relationship among crops, and household labor and other interdependencies among activities in the farm systems of Nepal hills, mathematical programming appears to be a much superior technique to examine effects of many alternative available policy options (Tulachan, 1989).

The sensitivity analyses in this study has been done for Sankhu site which covers various changes in output prices, wage rate, labor demand for off-farm activities, discount rate, and different scenarios of farming systems and policy variables.

5.1. Scenario I: Changes in Prices

5.1.1. Changing Output Price of Orange

Changing the output price especially, the price of orange fruits play an important role in the optimum plan and the profitability of the enterprise. The results of the sensitivity analysis under various price assumptions showed the changes in net present value of income and on land use by changing price from base run to NRs. 5 and 10.0 (Table 23 and 24). When price is decreased to NRs. 5.0 (by 28%) the optimal solution will only include rice in all farm groups. However, increase price from Nrs. 7.0 to 10.0 (by 42%) will substitute rice completely by orange in all

three farm groups except group I (marginal farm). The marginal farms will have still same amount of land devoted for rice production as in basic plan which indicates that they are not responsive to increased price of orange until this range probably because of the profitability of rice under its given resource endowments and technology. This also depicts the preference criteria of margianl farms for their subsistence requirements of rice.

Table 23. Effect of change of orange price on NPVI for different farm group in Sankhu (Base price of orange = NRs 7/kg)

Farm group	NPVI in different price range NRs./kg of fruits		
	7.0	5.0	10.0
I	161,053	158,029	194,818
II	223,774	195,707	241,486
III	382,191	332,630	407,293
IV	493,410	406,625	539,183

The switching over of rice land to orange by medium and large farms in response to higher orange price could be possible in some areas of mid hill where rice is grown in hill terraces under rainfed or partially irrigated conditions. It is reported that farmers in some of the road side areas of mid hills (Lamjung and Gorkha districts) where rice is grown on monsoon rains, is being converted to orange production because of its higer profitabiltiy.

Table 24. Effect of orange price change on optimal crop plan in various farms in Sankhu (Base price of orange = NRs 7/kg)

Farm groups	Various price changes in orange (in Nepal rupees)					
	7.0		5.0		10.0	
	rice	orange	rice	orange	rice	orange
I	0.37	6.25	0.37	6.25	0.37	6.25
II	0.00	15.56	15.56	0.00	0.00	15.56
III	0.00	26.72	26.72	0.00	0.00	26.00
IV	1.70	44.38	46.01	0.00	0.00	46.09

Note : Crop area in ropani(1 ropani area = 0.05 ha.)

5.1.2 Sensitivity of orange production to yield and price decline after middle of the planning horizon

a. Price decline by 15% after middle of the planning horizon

This analysis has been done here to take into account of market risk in the future When majority of the farmers integrate citrus into their existing systems. In this assumed situation, in the near future the market most likely would be flooded and price of orange would decrease substantially if proper market outlet is not developed. Therefore, sensitivity analysis has been done here by decreasing the price coefficent of orange from NRs 7.0 to 6.0 (about by 15%) after 10 years of planning period in order to take into account of market risk of growing orange (Table 25).

Table 25 Effect of 15% price decline on NPVI after middle of planning horizon

Farm groups	NPVI in decreased (15%) price of orange	
	NRs. 7.0	15% low price
I	161,053	155,395
II	223,774	195,707
III	382,191	333,946
IV	493,410	443,409

* Two price regime that is base price (NRs. 7.0 /kg) is used in the first 10 years and NRs. 6.0 /kg of fruit (15% lower) is used from the 11th year to 20th year of the planning horizon .

Table 26. Effect of 15% price decline on optimum crop plan after middle of planning horizon (10 years)

Farm groups	Optimal crop plan in 15% price decline			
	NRs. 7.0/kg		15% lower price	
	Rice	Orange	Rice	Orange
I	6.25	0.37	6.62	0.00
II	0.00	15.56	15.56	0.00
III	0.00	26.72	22.96	3.75
IV	1.70	44.38	7.91	38.17

The Table 26 reveals that even under adverse situation of price decrease by 15%, orange comes in optimal plan along with rice and off-farm activities in group III and IV (medium and large farmers). This finding is also supported by the feasibility studies conducted for citrus farming project by APROSC (1989) where citrus is economically viable even under adverse situation of price decline 10% and cost increase by 10%. However, orange does not come in the optimal plan for farm group I and II though

net present value of income is high since it will not be so profitable to grow orange as compared with rice. This could because of the interaction of several factors including relatively more labor resource endowments of marginal farms and higher gross margin from the production of rice. This finding reveals that smaller farm sizes are more sensitive to price change of orange compared with large farmers (Table 26).

b. Yield decline by 15% after middle of planning horizon

The objective of this analysis is to account the yield risk of declining production after tree reaches maturity. It is often common that farmers in the many rural hill areas suffer from declinng yield of orange tree because of diseases, pest and climatic variability (e.g. hail storms). In order to account this factor into analysis lower yield coefficients of orange is employed.

Table 27 Effect of yield decline on NPVI after middle of planning horizon

Farm groups	NPVI under declining orange yield situation	
	Base run	Decline Yield
I	161,053	155,395
II	223,774	195,707
III	382,191	333,946
IV	493,410	411,688

The programming analysis (Table 27) also show that orange is profitable

for group III and IV (medium and large farms) even under the projected lower yield (15%) situation after middle of the planning horizon.

Table 28 Effect of yield decline on optimal crop plan after middle of planning horizon

Farm groups	Optimal plan under declining orange yield situation			
	Base run		Decline Yield	
	Rice	Orange	Rice	Orange
I	6.25	0.37	6.62	0.00
II	0.00	15.56	15.56	0.00
III	0.00	26.72	22.96	3.75
IV	1.70	44.38	16.60	29.48

The programming results presented in Table 28 revealed that the crop mix in the optimal plans are orange and rice in the III and IV groups (medium and large farms) and only rice in group I and II (marginal and small farms) which is similar to projected lower price conditions. This findings also indidcate that smaller farms will be affected by yield decline in the long period where as medium and large farms are virtually unaffected.

5.2 Scenario II: Changes in demand for Off-farm labor

From household survey results of the study site, it has been found that about one or two adult members from marginal and small farm households in the study sites are employed in off-farm activities for a

period ranging from two to eight months. In order to test the sensitivity of the basic optimum plan under various labor demand conditions, assumption has been made in the model by reducing off-farm labor constraint coefficients to 75%, 50%, and 30% of the total actual supply. The results showed drastic reduction in NPVI (Table 29).

Table 29. Effect on NPVI due to variation in the demand for off-farm work (base demand = 100%) in Sankhu

Farm groups	Variation in the demand of Off-farm work (man days)			
	100%	75%	50%	30%
I	161,053	102,538	89,009	51,506
II	223,774	184,812	142,878	107,077
III	382,191	273,993	214,709	165,367
IV	493,410	390,025	313,190	250,085

When labor demand is 50% and 30% of the total supply, the optimal plan includes relatively more area under rice as orange production becomes not so profitable. This could be so because of lack of enough fund to invest on orange due to reduction of income from off-farm activities. When labor demand is only 25% of the total supply, the solution becomes infeasible as the family income will not be enough to meet basic consumption requirements and investment on fruit tree. Therefore, in this situation farm households need to borrow credit for the investment on orange .

Table 30. Effect on optimal crop plan due to changes of demand for off-farm work (base demand = 100%) in sankhu

Farm group	Optimal crop plan in various labor demand in off-farm work (man days)							
	100%		75%		50%		30%	
	rice	orange	rice	orange	rice	orange	rice	orange
I	0.37	6.25	0.37	6.25	3.05	3.57	6.00	0.61
II	0.00	15.56	3.68	11.87	3.16	12.39	8.53	7.02
III	0.00	26.72	2.59	24.12	9.70	17.00	15.38	11.34
IV	1.70	44.38	14.80	31.28	15.22	30.86	21.34	24.74

The results of this analysis indicates that there is positive relationship between off-farm work and investment on orange production as area under orange decreases with less demand of off-farm work (Table 30). This is because decrease demand for labor results reduction in off-farm income, consequently low net present value of income which in turn leads to switch over to rice as there will be low investment in orange production. Therefore, area under annual crop (rice) increases as demand for off-farm work decreases indicating negative relationship between rice production and off-farm employment (Table 30).

If off-farm employment opportunities are completely withdrawn, the farm households in both the study sites would have no sufficient family income to meet basic consumption requirements and investment for orange fruits. Therefore, the basic plan becomes infeasible for all farm sized

groups. This indicates that off-farm income is indispensable for not only long term investment in orange trees but also sustaining the basic livelihood of resource poor hill farmers. This result is consistent with result of Yaha, *et al.* (1992) who found that off-farm income is important in expanding permanent farming systems in the Highland of Chiangmai province, Northern Thaailand.

5.3 Scenario III: Effect of capital (credit) borrowing

Though programming model includes provision for borrowing credit from institutional sources for investment on citrus when existing capital is exhausted the results revealed that no credit was found borrowed in all farm groups untill the farm households are partially employed (> 25% demand) in off-farm during off-season. However, when exisitng off-farm work days are reduced to less than 25% of the original base demand, then without credit borrowing investment on orange is not possible. Therefore citrus growing households would not be self-financed and credit borrowing is required if farm households spend less than 25% of their available work days in off-season as revealed by programming results.

This results is also relevant to actual situation of the field as farm households in Sankhu site have already utilized about 52% of their available work days during offseason in off-farm activities and found earning sufficient income from off-farm employment (brick making, trekking, construction works and other various side line activities

including trade and services) to finance for citrus production. Therefore, in majority cases farmers hesitate to borrow credit from institutional sources due to high transaction costs and also the less information about actual borrowing procedures. In the existing situation only few households who do not have remunerative employment have used borrowed money from institutional sources in citrus production. The Marginal value product of credit was found high under less off-farm employment situation, indicating crucial role of credit if off-farm employment is not remunerative and opportunity costs of labor is very low or zero.

5.4 Scenario IV: Changes in off-farm Wage rates

The basic model for off-farm wage work includes valuation of family labor during off-season equivalent to usual rate for hired male labor during the peak farming season. Here the implicit assumption is that the opportunity cost of family labor equals the market wage rate and does not consider the differences in sexes and skills. However, such assumption is not always valid because the opportunity costs of family labor varies over the season and years due to seasonality in its demand.

Therefore, in this case parametric programming analysis has been carried out by changing off-farm wage rate equal to opportunity cost of family labor during both slack and peak farming seasons. It is assumed that farmers would earn 75% to 50% of the going wage rate during slack season and 125% to 166% of the going wage rate during very busy time of the farming.

Table 31. Effect of off-farm labor wage rates on NPVI for different farm groups (base wage rate (Wo) = NRs. 60.0)

Farm group	Changes in off-farm wage rate (NRs.)				
	Wo	W1	W2	W3	W4
	60.0	45.00	30.00	75.00	100.00
I	161053	127915	106048	189025	245075
II	223774	166521	130964	234272	289612

The rest two groups of farms (group III and IV) were not used for the analysis as for them, off-farm work especially wage laboring was not prevalent. The results from the Table 31 and 32, show that there is a change in the optimal plan showing that changing the off-farm wage rate will substantially change the optimal plan and net present value of income. The optimal area under orange increases with the farm size and increasing the wage rate. The results also depict that remunerative off-farm work will lead to inclusion of more area under orange as observed from Table 32 because off-farm income provides ready cash for the investment on orange production.

Table 32. Effect of off-farm labor wage rates on optimal crop plan in Sankhu (base wage rate = NRs. 60.0)

Farm group	Optimal area allocation under different crops									
	60.0		45.0		30.0		75.0		100.0	
	rice	orange	rice	orange	rice	orange	rice	orange	rice	orange
I	0.37	6.25	0.37	6.25	1.18	5.43	0.00	6.62	0.00	6.62
II	0.00	15.56	3.04	12.51	7.13	8.425	0.00	15.56	0.00	15.56

5.5 Scenario V: Changes on discount rate

Discount rate which indicates cost of capital is an important factor that determines the profitability of the farm systems. In this study, two discount rate 12% (interest rate for fixed deposits) and 20% (interest rate for consumption loans) have been used to see the changes on NPVI and optimal crop plan. Both use of lower and higher discount rate have significant effect on NPVI (Table 33). The results also show that higher discount rate substitutes the orange by rice completely in all the farm groups. Similarly, lower discount rate of 12% changes the optimal crop mixes but except in group I farm (Table 34).

Table 33. Effect of changes on discount rate on NPVI in different farm types in Sankhu (base discount rate = 16%)

Farm Group	Variation in discount rate		
	16%	12%	20%
I	161,053	206,593	136,894
II	223,774	269,411	164,143
III	382,191	453,609	278,693
IV	493,410	583,982	340,281

In this case group I (marginal farms) will have both rice and orange production in the optimum plan as similar to basic plan which indicates that they are not responsive to lower discount rate.
If government provides a subsidy in the credit disbursement by reducing present interest rate from 16 to 12%, then farm groups II, III and IV will

switch over from rice to orange production as it is more profitable for them. However, the optimal plan of group I farm will have no changes in cropping plan except increase in net present value of income (Table 34) which depicts that they are not responsive to lower discount rate.

Table 34. Effect of changes on discount rate on optimal crop plan in Sankhu (base discount rate = 16%)

Farm group	Optimal area allocation under different crops					
	16%		12%		20%	
	rice	orange	rice	orange	rice	orange
I	0.37	6.25	0.37	6.25	6.62	0.00
II	0.00	15.56	0.00	15.56	15.56	0.00
III	0.00	26.72	0.00	26.72	26.72	0.00
IV	1.70	44.38	0.00	46.00	46.01	0.00

This is probably because of the no significant increase on the saving of return to invest on orange for its future even under low discount rate and in addition to this, rice becomes relatively profitable for this group. In the reality also rice land for marginal farms is essential for meeting consumption requirements. Therefore strong institutional credit support services are required to attract group I or marginal farms in the investment on citrus fruits.

5.6 Scenario VI: Fully Upland Situation

The analysis and simulation of farm plan under the assumption of

fully upland situation seems quite meaningful as many of the farm households in the hills of Nepal have only rainfed upland for agricultural production and many of the small farm household rarely own paddy land (khet) for rice cultivation. This is also observed in the present study sites where 15% of sampled households did not have low land. Integration of perennial high value crops like citrus in the upland situation should be a good alternative to increase long term farm income as return from existing maize based systems is declining.

Unlike the basic optimum plan the results showed that orange is the only upland crop that comes into the optimal solution (Table 35). However, in this situation growing mustard is cost effective as it does not bring any reduction in the objective function value. But there is slight reduction in the NPVI (5%) as compared with base run due to omission of rice production activities in the model.

Table 35. NPVI and optimal crop plan in upland situation in farm group I in Sankhu

NPVI & Optimal Crop	Unit	Orange with upland crops & Rice (Base run)	Orange with upland crops & no Rice (A)	Systems with only annual upland crops (B)	% Difference (A/B)*100
NPVI	(NRs.)	161053	152048	132396	14.84
Optimal crop	area	6.62	6.62	6.62	0.0

Orange	ropani	6.25	6.62	0.0	0.0
Rice	,,	0.37	-		
Mustard	,,	-	-	6.62	0.0

Despite this, the system with upland crops and citrus is still found 14% more profitable as compared to the systems with only upland crops. No much changes on optimum plan and return were observed by omitting rice in the optimum plan.

5.7 Scenario VII: Effect of improved technology and marketing

The sensitivity analysis was also done by comparing existing situation versus improved situation with better technology, and improved marketing practices. Input- output coefficients for improved situation of citrus integration is prepared by using today's most advanced technologies adopted in research stations, and commercial farms under the assumption that over time a sizeable number of farmers will tend to adopt this advanced technology.

a. Effect of improved technology (planting material) and cultural management of citrus

It is widely believed that improved technology of fruit trees such as improved genotype plays important role in improving farm productivity and income. However, the multiperiod programming analysis of the improved mandarin orange in Sankhu site showed that there was not much impact of improved genotype on long term family income as compared with traditional genotypes under present production systems, resource availability and constraints of the farm households (Table 36).

Table 36. Effect of improved technology and management practices of citrus on NPVI and Optimal plan for farm group I in Sankhu.

NPVI & Optimal plan	Existing situation (NRs)	Improved situation (NRs)	Difference %
NPVI	161,053	165,766	3
Optimal plan			
Rice	0.37	0.37	0
Orange	6.25	6.25	0

Despite the higher potentiality of improved mandarin fruit trees in terms of yield and better quality fruits this minimal effect of technology was because of the demand for relatively higher amount of resources particularly that of purchased inputs and hired labor, in addition to shorter economic life of improved mandarin orange. This indiccates that when marginal productivity of labor is high that is if off-farm employment is remunerative the introduction of new technology in citrus will have less impact on improving income.

b. Effect of improved marketing practices in citrus

In order to know the impact of direct marketing of fruits at near by markets input-output coefficients for direct marketing practices has been used for programming analysis. Farmers were found to recieve NRs.

7/kg of fruit in the existing situation as compared with the direct sale at market in NRs. 10 /kg of fruits.In this analysis the transportation and harvesting costs are added in the total costs where as most of the other things remained other same.

Table 37. Impact of Improved marketing practice of citrus on family income (NPVI) and Optimal Plan in group I farm in Sankhu

NPVI	Return from different Marketing practices in citrus		
	Existing* NRs	Improved** NRs	Difference %
NPVI	161,053	181,040	15.2
Optimal plan			
Rice	0.37	0.37	0.0
Orange	6.25	6.25	0.0

* Existing = marketing fruits to preharvest contractor at farm gate.
** Improved = marketing by farmers themselves in the near by markets.

The programming results which are presented in Table 37 indicated that, there is a greater impact of improved marketing practice in NPV of income than that of improved technology (improved orange genotype) in Sankhu site . This is because farmers receive higher price of orange fruit (>30%) just through slight changes in marketing practice that is from contract selling before harvest to direct marketing after harvest which has been already practiced by some of the resource rich farmers.

5.8 Scenario VIII: Intercropping food crops at juvenile stage of orange tree

Survey results show that small holders because of their very small size of farm prefer to intercrop food crops during juvenile stage of orange to fulfill their basic consumption requirements. Therefore, MLP analysis has been done in the basic optimum plan particularly for group I (marginal farmers) in order to see the effect on the net present value of income and thereby profitability of the systems with and without intercroping of food crops between trees. The input- output coefficients of commonly intercropped food crops: maize during summer and mustard in the winter are used in the programming model for planning.

Table 38. Changes in optimal plan and Income (NPVI) by intercropping crops with orange trees in Sankhu (group I).

NPVI & Optimal plan	Systems W/o * Intercropped orange	Systems With Intercropped orange	Difference
NPVI	161972	165572	2.9(%)
Optimal plan			
Rice	0.37	3.27	2.9
Orange	6.25	3.35	-2.9

W/o * = Without

In calculating coefficients for intercropped situation, 90% area

was occupied by the annual crops in the year I. In year II and III 80 and 70% of the area were devoted for intercrops respectively. For the year 4th and 5th 60 and 50% area were used for this purpose. The resources required and output obtained were estimated based on the area in the intercropping. There is slight increment in net present value of income by 2.9 % when food crops (maize and mustard) are intercropped during juvenile stage of mandarin orange tree (Table 38). However, there is a decrease in the area under orange in optimal plan by intercropping.

Despite decrease of the area under orange and slight increase in NPVI, intercropping at juvenile stage is beneficial for small farm households as it provides not only food security but also compensate the foregone production from land occupied by citrus. Such intercropping also provides income for investment on orange fruits for resource poor farmers.

5.9 Summary

Sensitivity analysis of the existing citrus based farming systems of Sankhu site indicates that off-farm employment has important role for the economic viability of hill farming systems and without off-farm employment it is not only difficult for meeting household consumption requirements but also in the investment on citrus production. Off-farm work by farm family members always enter the optimal solution for every farm group in all the planning period until 20th year. It is also found that in the future when wage rate increases, orange becomes more

profitable so farmers would switch into orange from rice as they would earn more income from off-farm. The results also point out that even under the well established orange production systems there is still room for family members to engage in off-farm work during slack period of the farming.

In addition to off-farm employment and wage rate, output price of orange, discount rate used and improved marketing practice also had some impact on improving long term farm income and investment on orange production. Increased orange price from NRs. 7 to 10 /kg (by 42%) and decreasing discount rate from 16 to 12% make farm groups completely to switch over to orange production while group I farms still have rice land in their optimum plan including orange and off-farm works. Price and yield decline of orange after middle of planning horizon will make marginal and small farm households to substitute orange to rice completely while members of the large and medium farm groups are unaffected by this type of adverse situation.

The role of improved technology of citrus and intercropping at Juvenile stage had minimal impact on long term income despite the fact that intercropping might improve food security and reduce the risk of investment in orange production. However, the analysis showed that improved marketing had greater impact since farm households can improve their income substantially due to higher price received from direct sale of fruits.