

CHAPTER 12

FURTHER SENSITIVITY ANALYSES

Sensitivity analyses are useful when attempting to determine the impact a change in a particular variable will have on the results obtained previously. On the other hand, sensitivity analyses can be done by changing the parameters of the model. By creating a given set of model changes, the sensitivity analyses determine how change(s) impact the target variable. In this study, the latter part of sensitivity analyses determined different values for a particular dependent variable and looked at the impact to the farm and watershed levels.

12.1 Further sensitivity analyses at the farm level

This part of sensitivity analyses has a set of 3 assumptions which are broken into the 4 situations listed below:

1. Price variations due to market integration as a result of the economic strategy within the ASEAN community in 2015. This will increase the size of the potential market and there will be reduced tariffs within the community to promote regional trade. It is expected that all products will experience an increase in market demand and price. This could increase the weight value of the annual equivalent value goal (GA) by as much as 20 percent from the weight value in the equal weight method results. The goal levels used in this analysis were set at 17.14 percent while all the other goals were equal at 13.81 percent.
2. Increased independence from external inputs such as hired labor or farming supplies that have to be purchased such as chemicals and fertilizer. This can be achieved by a policy which encourages farmers to use organic matter on their

farms which is more environmentally friendly and at the same time will decrease their costs. In the equal weight method results, the goals for independence from external inputs (GI) and hired labor (GH) already had a target goal of 0. This only leaves off-farm work (GS) as the remaining variable which can be changed. This study sets a possible decrease in the weight value of 30 percent in the off-farm work goal as this labor could be better used as household labor on their own farms. This will lead to a decrease in hired labor, costs and loan activity but will lead to an increase in the annual equivalent value. For this analysis, the off-farm work goal (GS) has been decreased by 30 percent and the goal level has been set at 10 percent, while all the other goals are equal at 15 percent (Table 12.1).

Table 12.1 Goal levels used in the sensitivity analysis at the farm level

Goals	Equal weight method	GA increase by 20%	GS decrease by 30%
GA	14.29	17.14	15.00
GH	14.29	13.81	15.00
GI	14.29	13.81	15.00
GL	14.29	13.81	15.00
GY	14.29	13.81	15.00
GR	14.29	13.81	15.00
GS	14.29	13.81	10.00
Total	100	100	100

3. A change in the coefficients for the input/output tables of activities for the optimization of resource management at the farm scale. In this study, the research determined the following changes to the coefficients:
 - a. An increase in the wage rate coefficient from 200 to 300 baht per day. This increase is due to the government setting a minimum wage for hired labor.
 - b. The new ASEAN community will lead to an increase in the availability of hired labor as labor from less economically developed countries such as

Myanmar and Laos which are close to the Fang watershed will migrate in search of work. This study has increased the hired labor constraint by 30 percent. The researcher has allowed for an increase in the maximum number of man-days from 50 to 65 man-days per month for both the small farms using chemicals and the small farms using chemicals and bioextract. For the large farms using chemicals, it allowed an increase from 750 to 975 man-days per month and for the large farms using chemicals and bioextract, the labor constraint increased from 150 to 195 man-days per month. The study gave both the increase in the wage rate coefficient and the increase in the hired labor constraint a goal weight equal to the equal weight method results.

12.1.1 Results of the sensitivity analyses for the small farm using chemicals

1. Optimal land use management

When comparing the land use from the results, it can be divided into two groups for further analysis. The first group was made up from the increase in the wage rate coefficient and the increase in the hired labor constraint. The model assessed similar results to the equal weight method results which were a mix of approximately 75 percent fruit trees and 25 percent annual crops. The second group was made up from the remaining goals for which the composition was a mix of less than 55 percent fruit trees and more than 45 percent annual crops.

When the cropping systems in each land unit were compared, all the results from the sensitivity analyses found that the rainfed upland was optimal for coffee and sweet corn. The irrigated upland was optimal when planted with sweet corn followed by sweet corn. For the off-farm work goal (GS), a decrease of 30 percent showed four differences from the other results which were all within a small spread of each other. For the irrigated upland, coffee was omitted; for the irrigated lowland, citrus, and rice followed by sweet corn were omitted and for the rainfed lowland, lychee was omitted (Figure 12.1).

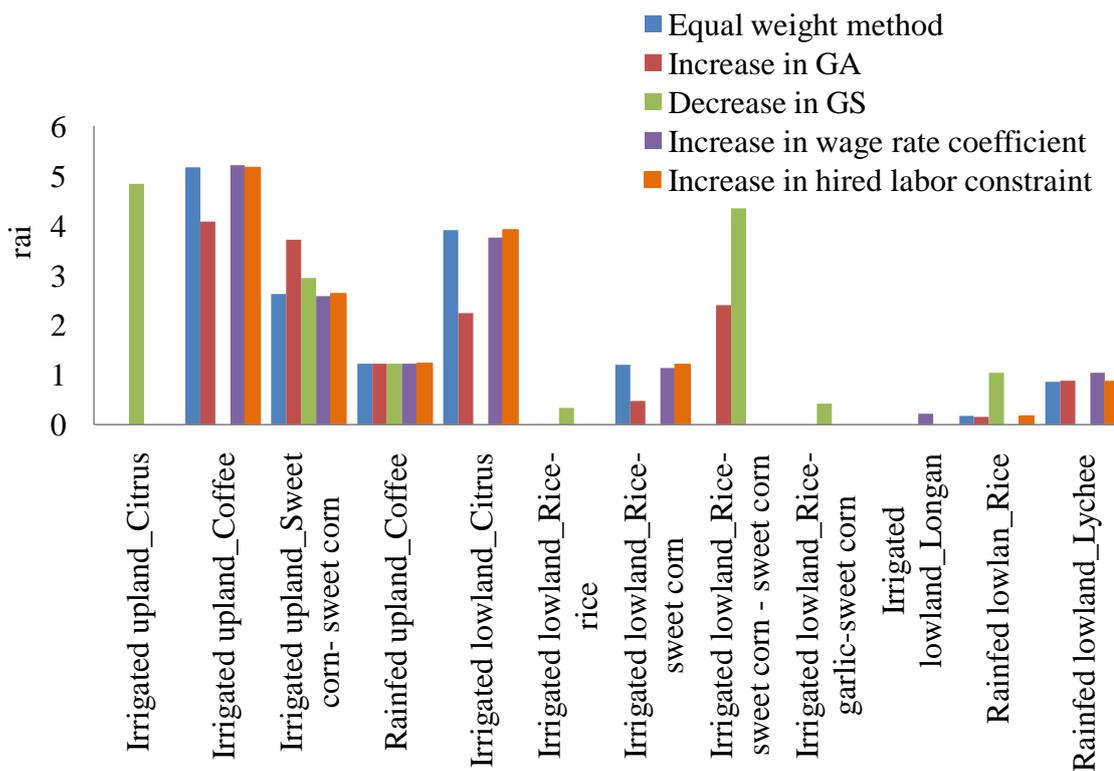


Figure 12.1 Optimal land use management from the sensitivity analyses for the small farms using chemicals

2. Off-farm work and hired labor

The model assessed that the total off-farm work per year was higher after an increase in the hired labor constraint to 82 man-days per year and lower after a decrease in the weight value of the off-farm work goal (GS) to 47 man-days per year. The other results were valued between 64 and 68 man-days (Figure 12.2).

For hired labor, if the constraint was increased by 30 percent from 50 to 65 man-days per month, the use of hired labor increased in every month when compared with the equal weight method results. The other sensitivity analyses such as the annual equivalent value goal (GA) gave similar results to the equal weight method results for hired labor where the maximum hired labor used remained at 50 man-days per month

during March, October and December and showed little variation for the other months (Figure 12.3).

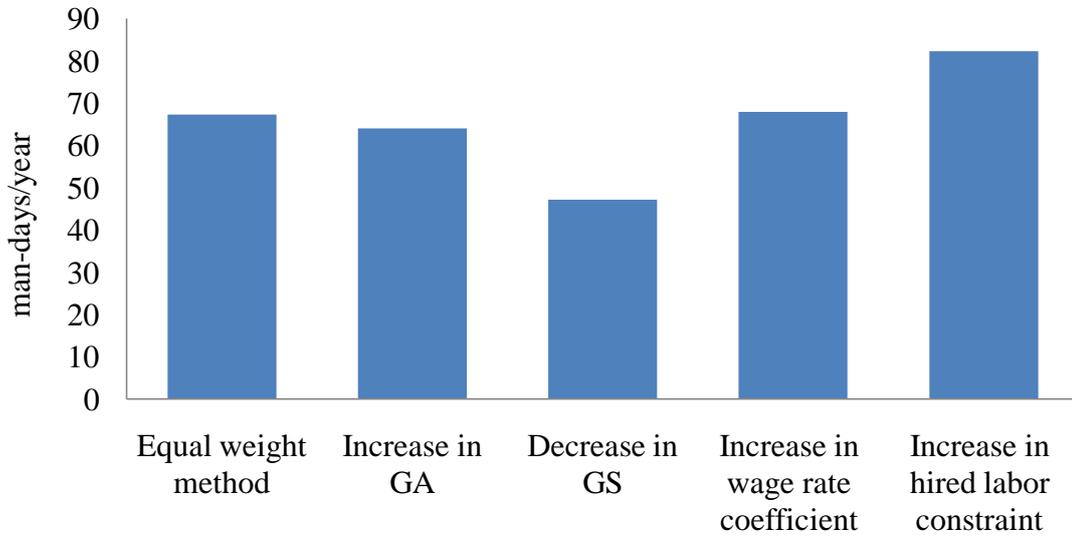


Figure 12.2 Optimal use of hired labor from the sensitivity analysis for the small farms using chemicals

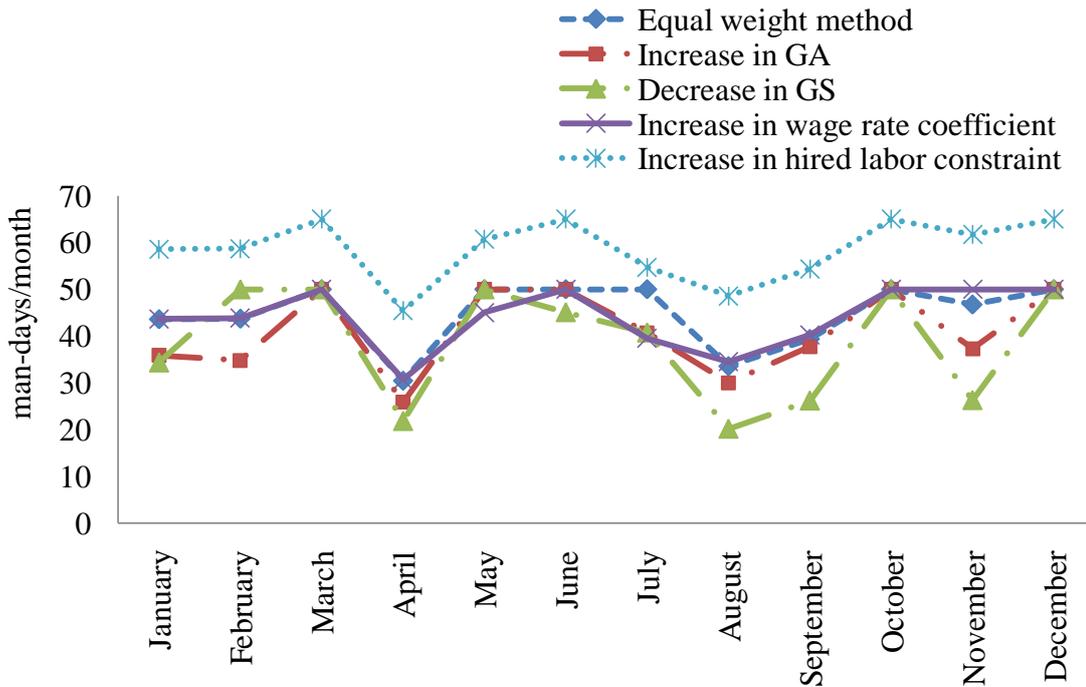


Figure 12.3 Optimal use of hired labor from the sensitivity analysis for the small farms using chemicals

3. Loan and repayments

The results found that an increase in the annual equivalent value goal (GA) and a decrease in the off-farm work goal (GS) showed a decrease in the loan and repayments to BAAC when compared with the equal weight method results. An increase in the wage rate coefficient and an increase in the hired labor constraint resulted in increased loans and repayments to BAAC when compared with the equal weight method results (Figure 12.4).

4. Net annual revenue from crop production

The net annual revenue was valued after the loan and repayments and household consumption were deducted. The results found that the decrease in the off-farm work goal (GS) led to the highest increase in the net annual revenue followed by the annual equivalent value goal (GA) when compared with the equal weight method results. An increase in the wage rate coefficient and the hired labor constraint showed a decrease for the net annual revenue when compared with the equal weight method results (Figure 12.4).

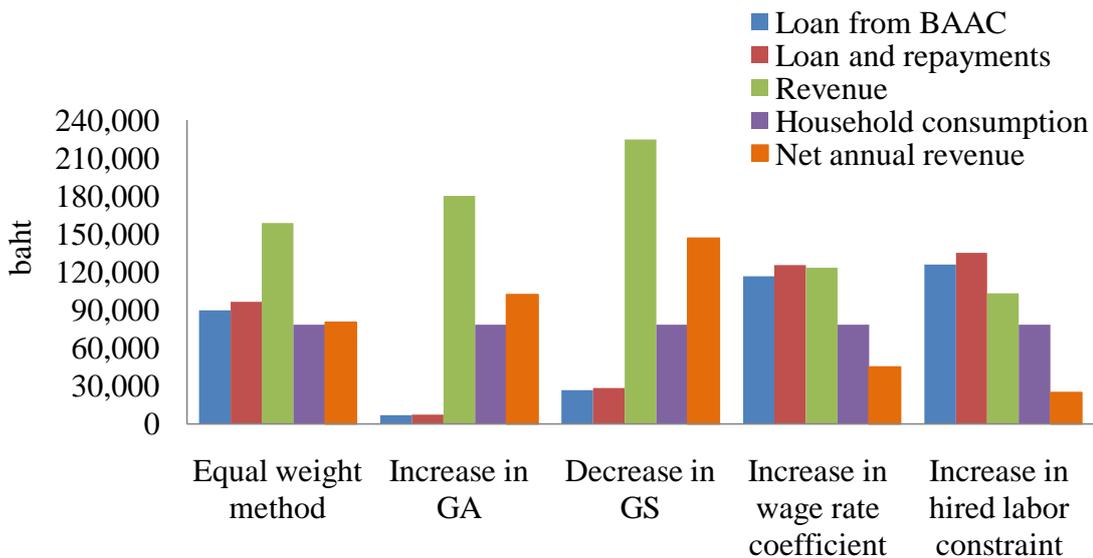


Figure 12.4 Optimal loan management and net annual revenue of sensitivity analysis for the small farms using chemicals

5. Goal achievement rate

The results found that overall, the sensitivity analyses achieved similar results to the equal weight method results. The greatest changes were seen with the goals of annual equivalent value (GA), off-farm work (GS) and loan investment (GL) whereas the changes were smallest with the yield variance (GY) and revenue variance (GR).

When comparing between the equal weight method results and the sensitivity analyses goal achievement rate, the results found that increases in the annual equivalent value goal (GA), the wage rate coefficient and the hired labor constraint gave equal or increased values from the equal weight method results. The increase in the annual equivalent value goal (GA) was especially notable. The spread of all the achieved goals were also reduced. When the equal weight method results were used, the spread between the achieved goals varied by 31.65 percent but this spread was reduced to 18.35 percent with the sensitivity analyses. A lower spread or variation in the achieved goals means that all the goals from the economic, social and environmental perspective are more equal.

The decrease in the off-farm work goal (GS) showed an increase only with the achieved goal of the annual equivalent value (GA). All the other achieved goals showed a lower figure than with the equal weight method results. The range of the achieved objective goals increased from 31.65 to 53.67 percent compared with the equal weight method results

When comparing all sensitivity analyses, an increase in the annual equivalent value (GA) gave better optimal resource management than the other sensitivities. The goal achievement rates were within a narrow spread of each other while the decrease in the off-farm work goal (GS) yielded greater divergences among different goals. For the other sensitivity analysis, the results are not so different from the equal weight method results (Figure 12.5).

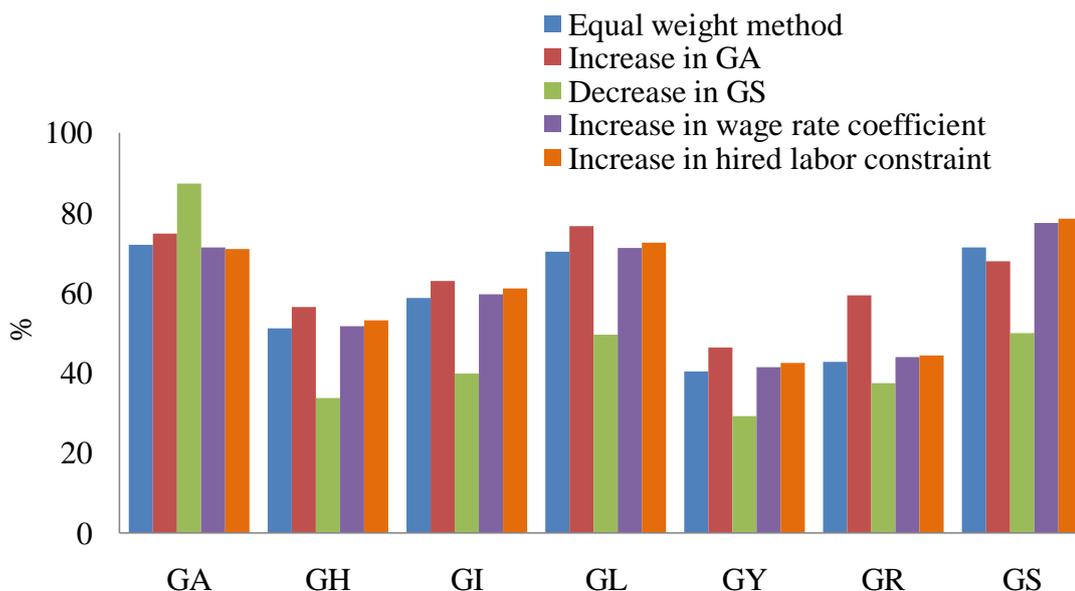


Figure 12.5 Objective goals achieved from the sensitivity analysis for the small farms using chemicals

12.1.2 Results of the sensitivity analyses for the small farms using chemicals and bioextract

1. Optimal land use management

The results found that an increase in both the wage rate coefficient and the hired labor constraint gave similar results to the equal weight method results which recommended planting fruit trees and annual crops equally at 50 percent each. An increase in the annual equivalent value goal (GA) recommended fruit trees at 42 percent and annual crops at 58 percent. A decrease in the off-farm work goal (GS) recommended fruit trees at 39 percent and annual crops at 61 percent. When we compared the cropping systems for each land unit, the results from all the sensitivity analyses found that the irrigated upland was optimal for coffee and sweet corn followed by sweet corn. The irrigated lowland was optimal for citrus, and rice followed by sweet corn and sweet corn. The rainfed lowland was optimal for lychee. These results are shown in Figure 12.6.

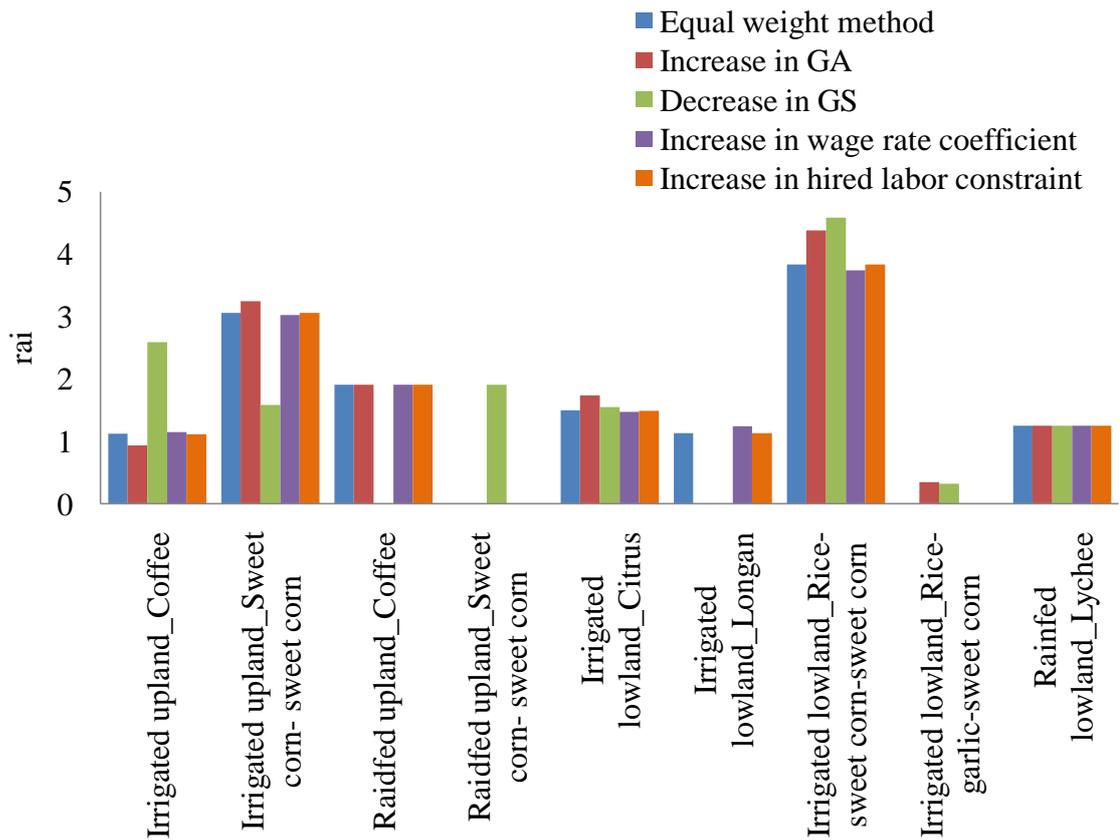


Figure 12.6 Optimal land use management from the sensitivity analysis for the small farms using chemicals and bioextract

2. Off-farm work and hired labor

The results showed that household labor was optimal for off-farm work at between 58 and 78 man-days per year (Figure 12.7). When the hired labor constraint increased by 30 percent, hired labor increased in every month which was different from the other sensitivity analyses results. The other sensitivity analyses results were similar to the equal weight method results where hired labor was at the maximum of 50 man-days per month during March, May, June, October and December (Figure 12.8).

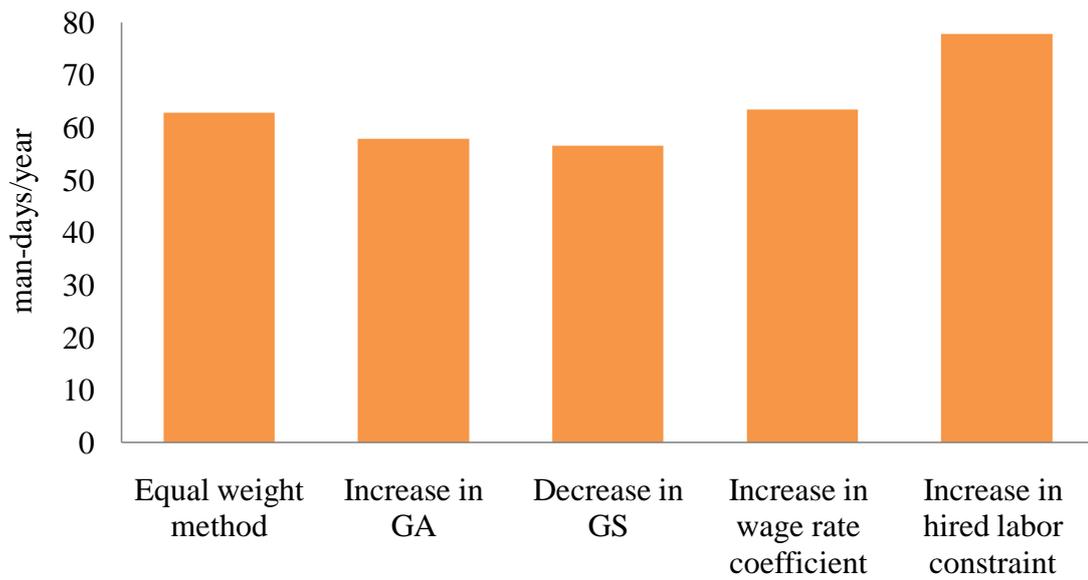


Figure 12.7 Optimal use of household off-farm work from the sensitivity analysis for the small farms using chemicals and bioextract

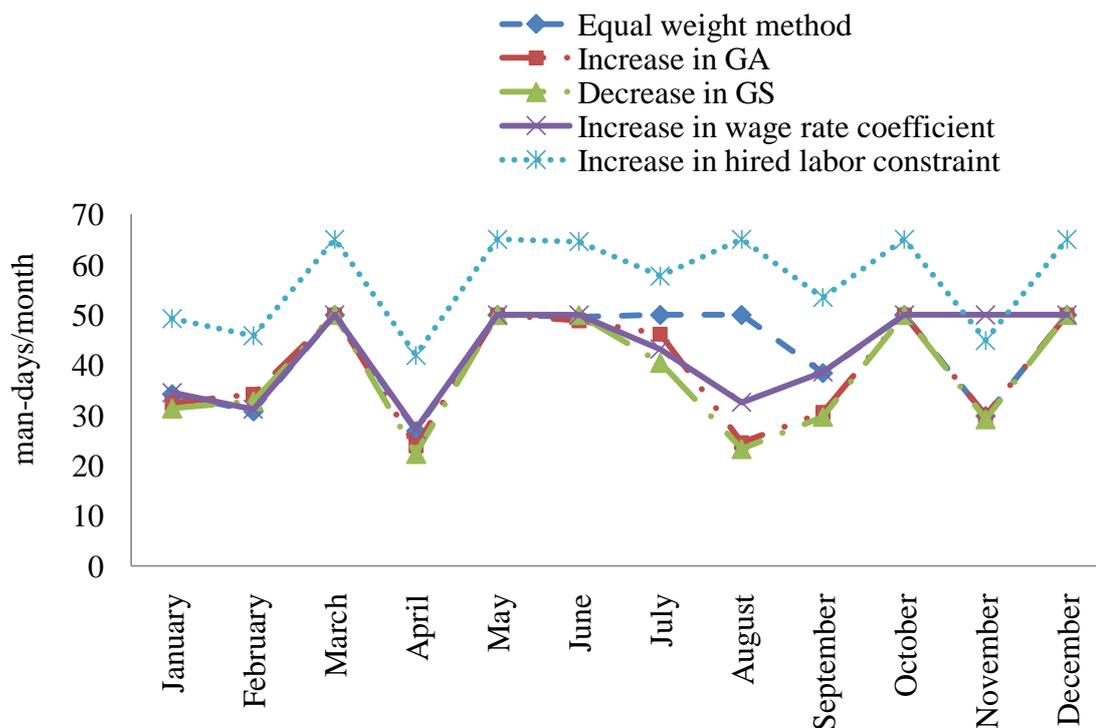


Figure 12.8 Optimal use of hired from the sensitivity analysis for the small farms using chemicals and bioextract

3. Loan and repayments

The model recommended not having a loan when there was an increase in the annual equivalent value goal (GA), a decrease in the off-farm work goal (GS) and an increase in the wage rate coefficient as the owner investment was sufficient. With the increase in the wage rate, the loan from the BAAC decreased to 4,179 baht from 124,870 baht by the equal weight method results. The BAAC had an interest rate of 7.5 percent per year with a total repayment of 4,492 baht (Figure 12.9).

4. Net annual revenue from crop production

The net annual revenue was valued after the loan, interest payments and household consumption were deducted. The results found that all the sensitivity analyses gave net annual revenue increases of between 29,135 baht and 67,960 baht as compared with the equal weight method results at 0 baht. The revenue at 0 baht with the equal weight method results was sufficient for the repayments for the loan and interest but insufficient for the household consumption (Figure 8.9). In a real situation, they would only repay the interest to BAAC so there would be money for household consumption and investment in the next crop (Figure 12.9).

5. Goal achievement rate

The results found that all the sensitivity analyses gave similar achieved objective goals to the equal weight method results. When we compared the equal weight method results and the sensitivity analyses, the results found that the increases in the hired labor constraint and the wage rate decreased the range of the achieved goals compared with the equal weight method results which meant the achieved goals were more equal. An increase in the annual equivalent value goal (GA) and a decrease in the off-farm work goal (GS) gave similar results to each other which also increased the range of goals to 46.44 from 36.09 percent compared with the equal weight method results (Figure 8.10). When comparing all sensitivity analyses, an increase in the hired labor constraint gave better optimal resource management followed by the increase in the wage rate

coefficient. The other sensitivities showed a small decrease from the equal weight method results.

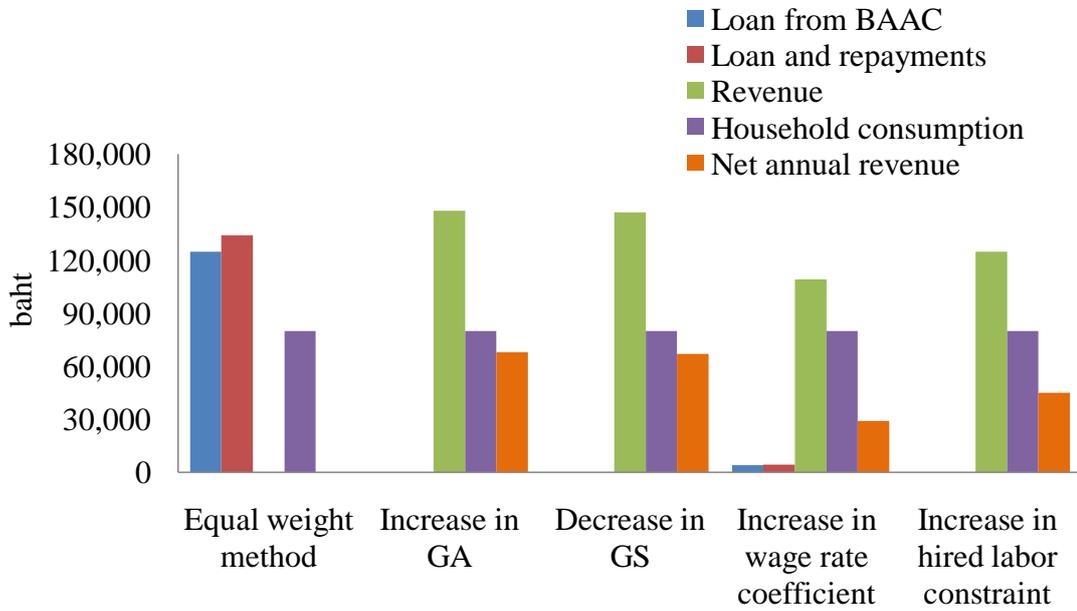


Figure 12.9 Optimal loan management and net annual revenue from the sensitivity analysis for the small farms using chemicals and bioextract

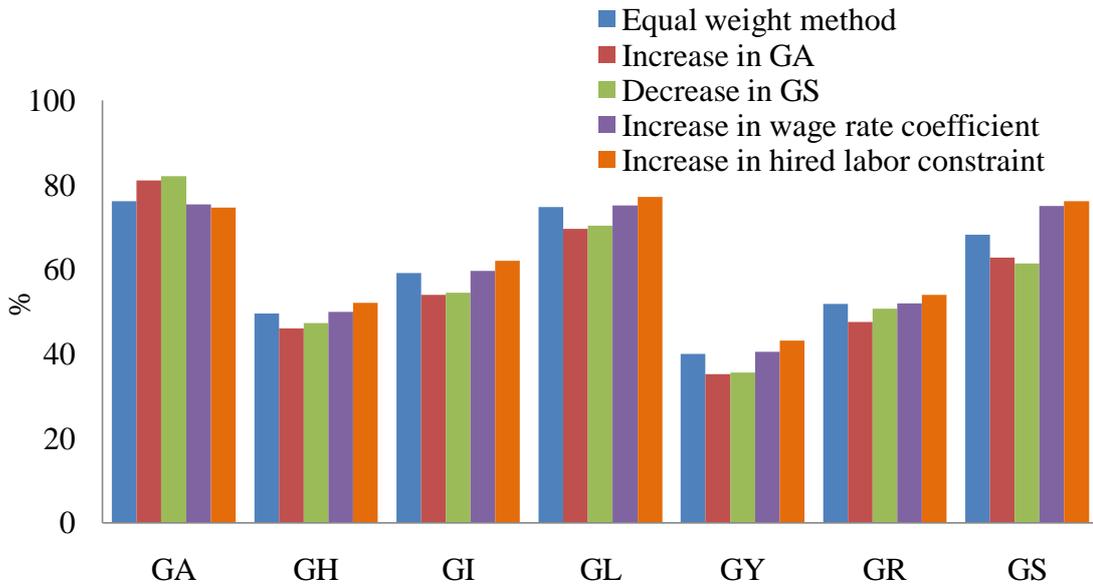


Figure 12.10 Objective goals achieved from the sensitivity analysis for the small farms using chemicals and bioextract

12.1.3 Results of the sensitivity analyses for the large farms using chemicals

1. Optimal land use management

The results found that all the sensitivity analyses gave similar results which assessed the optimal solution as citrus production at approximately 92 percent and annual crops at 8 percent. When we compared the cropping systems in each land unit, all the sensitivity analyses recommended the irrigated upland as being optimal for citrus and the rainfed upland was optimal for sweet corn followed by sweet corn. The irrigated lowland was optimal for citrus and the rainfed lowland was optimal for rice, (Figure 12.11).

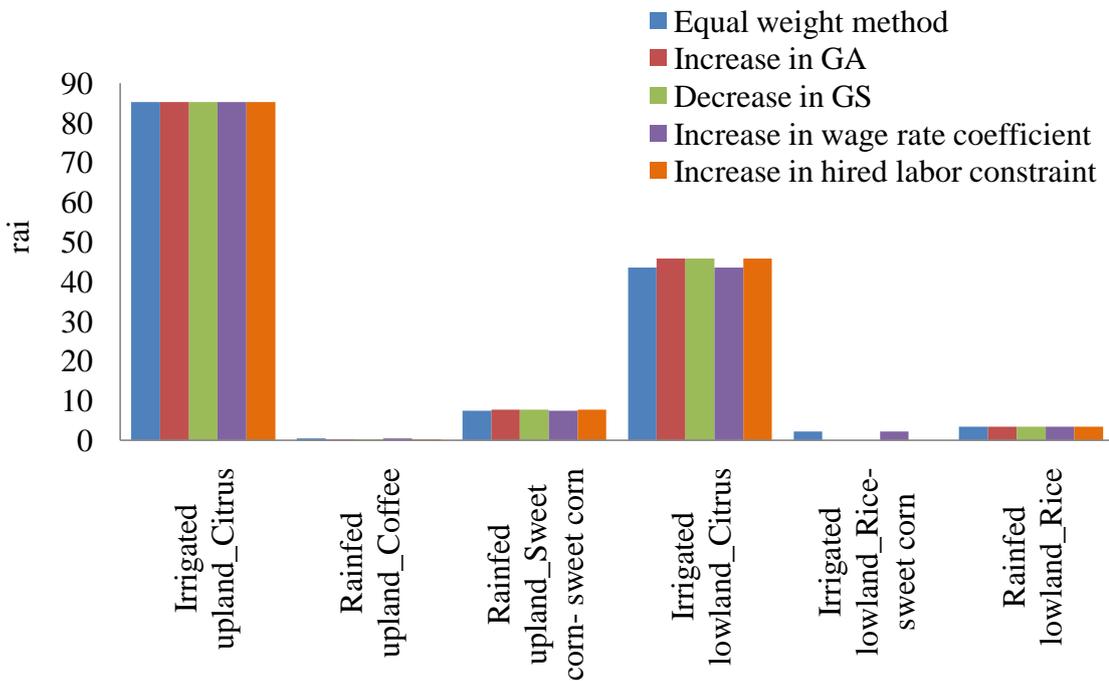


Figure 12.11 Optimal land use management from the sensitivity analysis for the large farms using chemicals

2. Off-farm work and hired labor

All the sensitivity analyses gave similar results to the equal weight method results for off-farm work at approximately 339 man-days per year. The exception was when the hired labor constraint was increased which gave an off-farm work figure of 564 man-

days per year (Figure 12.12). This was repeated with the hired labor where the sensitivity analyses gave similar results to the equal weight method results except when there was an increase in the hired labor constraint which resulted in an increase in the number of man-days (Figure 12.13).



Figure 12.12 Optimal use of household off-farm work from the sensitivity analysis for the large farms using chemicals

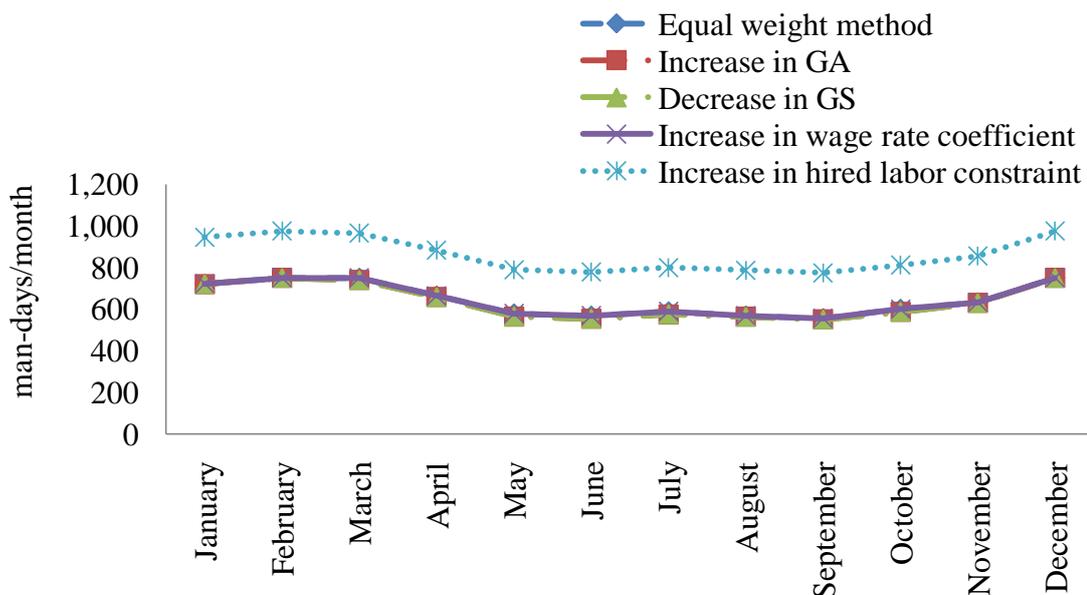


Figure 12.13 Optimal use of hired labor from the sensitivity analysis for the large farms using chemicals

3. Loan and repayments

The results found that all the sensitivity analyses showed an increase in the loan and repayments from the equal weight method results. An increase in the annual equivalent value goal (GA) and a decrease in the off-farm work goal (GS) assessed an increased loan from the commercial banks from 984,908 baht to 1,040,662 baht. The commercial banks had an interest rate of 8.0 percent per year with a total repayment of 1,123,915 baht. The increases in the wage rate and the hired labor constraint assessed an increase in repayments which were higher than in the other sensitivity analyses (Figure 12.14).

4. Net annual revenue from crop production

The net annual revenue was valued after the loan, interest repayments and household consumption were deducted. The results found that an increase in the annual equivalent value goal (GA) and a decrease in the off-farm work goal (GS) gave the net annual revenue as being equal to the equal weight method results. The increases in the wage rate coefficient and the hired labor constraint showed a decrease for the net annual revenue when compared with the equal weigh method results (Figure 12.14).

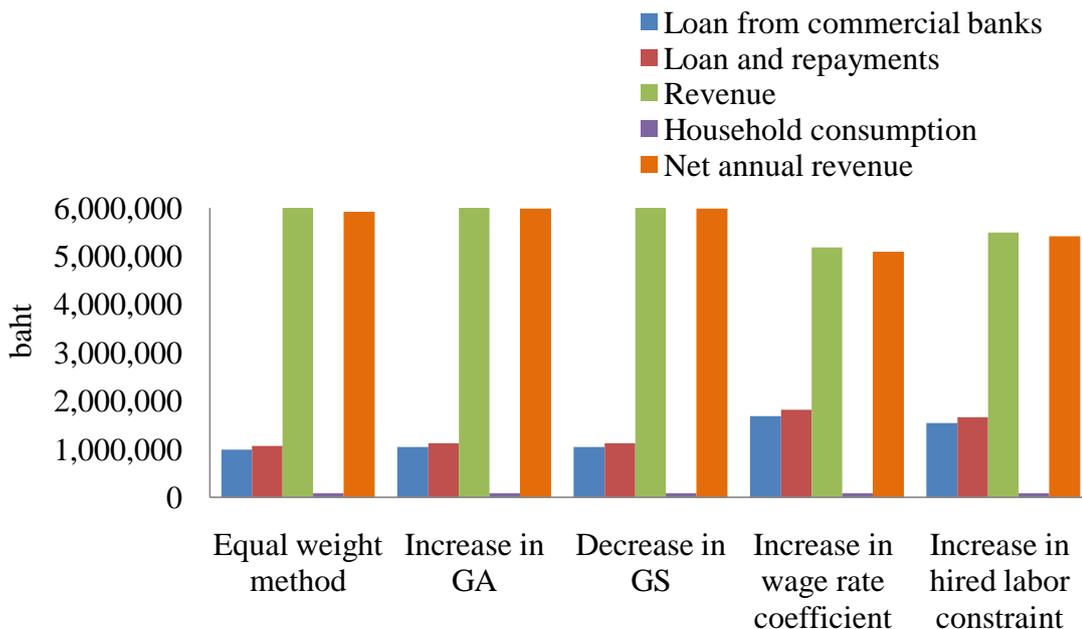


Figure 12.14 Optimal loan management and net annual revenue from the sensitivity analysis for the large farms using chemicals

5. Goal achievement rate

The results found that all the sensitivity analyses gave similar achieved objective goals to the equal weight method results. They were highest for the annual equivalent value (GA) and lowest for the yield variance (GY) and hired labor (GR).

When comparing between the equal weight method results and the sensitivity analyses goal achievement rate, the results found that an increase in the wage rate coefficient gave achieved objective goals similar to the equal weight method results. For the other sensitivity analyses, the results showed a slight increase from the equal weight method results (Figure 12.15).

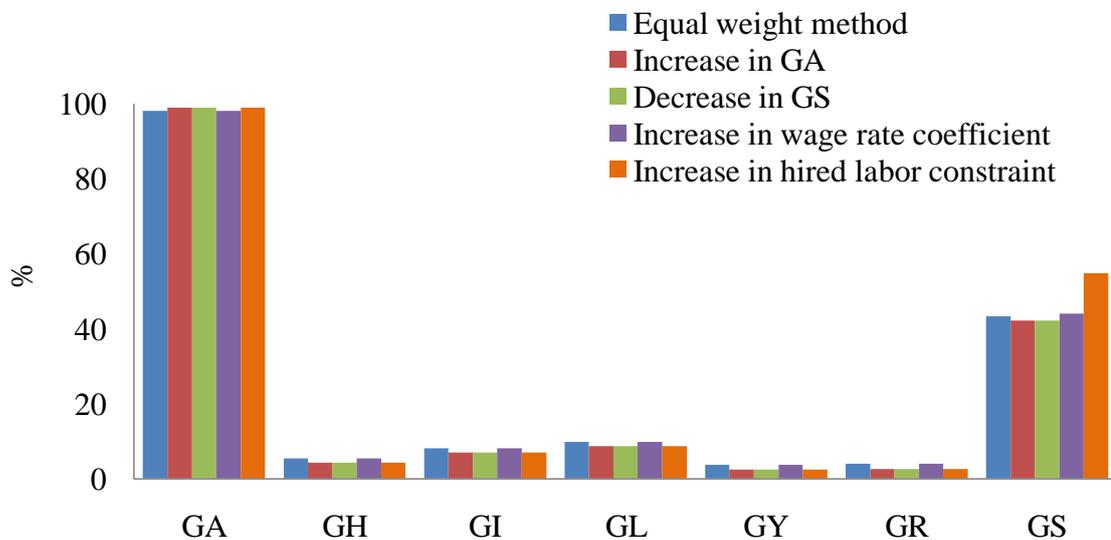


Figure 12.15 Objective goals achieved from the sensitivity analysis for the large farms using chemicals

12.1.4 Results of the sensitivity analyses for the large farms using chemicals and bioextract

1. Optimal land use management

The results found that all the sensitivity analyses gave similar results to the equal weight method results which recommended citrus production at approximately 63 percent and annual crops at 37 percent. When comparing the cropping systems for each land unit, the sensitivity analyses all gave similar results as shown in Figure 12.16.

2. Off-farm work and hired labor

The results found that an increase in the hired labor constraint resulted in an increase in off-farm work at 131.2 man-days per year, while the other sensitivity analyses were equal or lower than the equal weight method results (Figure 12.17).

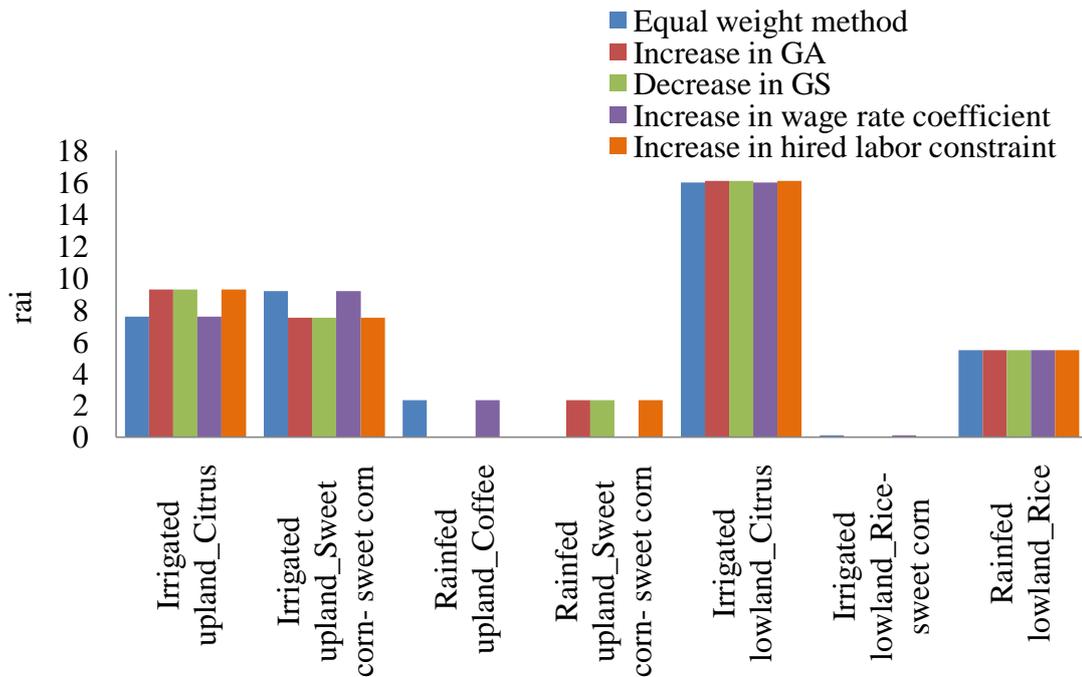


Figure 12.16 Optimal land use management from the sensitivity analysis for the large farms using chemicals and bioextract

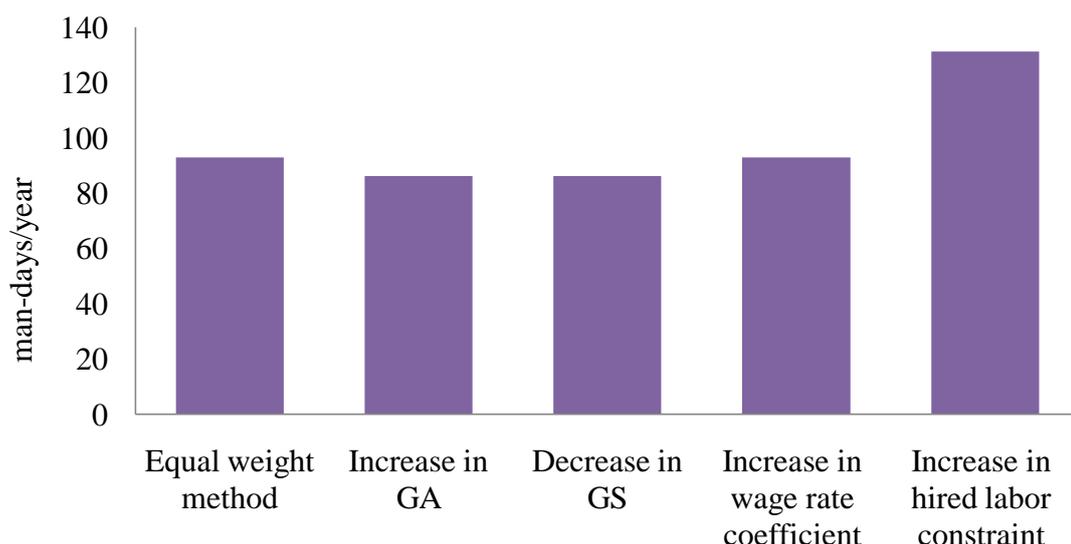


Figure 12.17 Optimal use of off-farm work from the sensitivity analysis for the large farms using chemicals and bioextract

If the hired labor constraint was increased by 30 percent from 150 to 195 man-days per month, the use of hired labor increased in every month when compared with the equal weight method results. The other sensitivity analyses such as the annual equivalent value goal (GA) gave similar results to the equal weight method results for hired labor where the maximum hired labor used remained at 150 man-days per month such as during January, February and December and showed little variation for the other months (Figure 12.18)

3. Loan and repayments

The results found that all the sensitivity analyses resulted in increased loan and repayments from the commercial banks. The adjusted figures varied from between 176,679 and 291,684 baht compared with 152,580 baht by the equal weight method results (Figure 12.19).

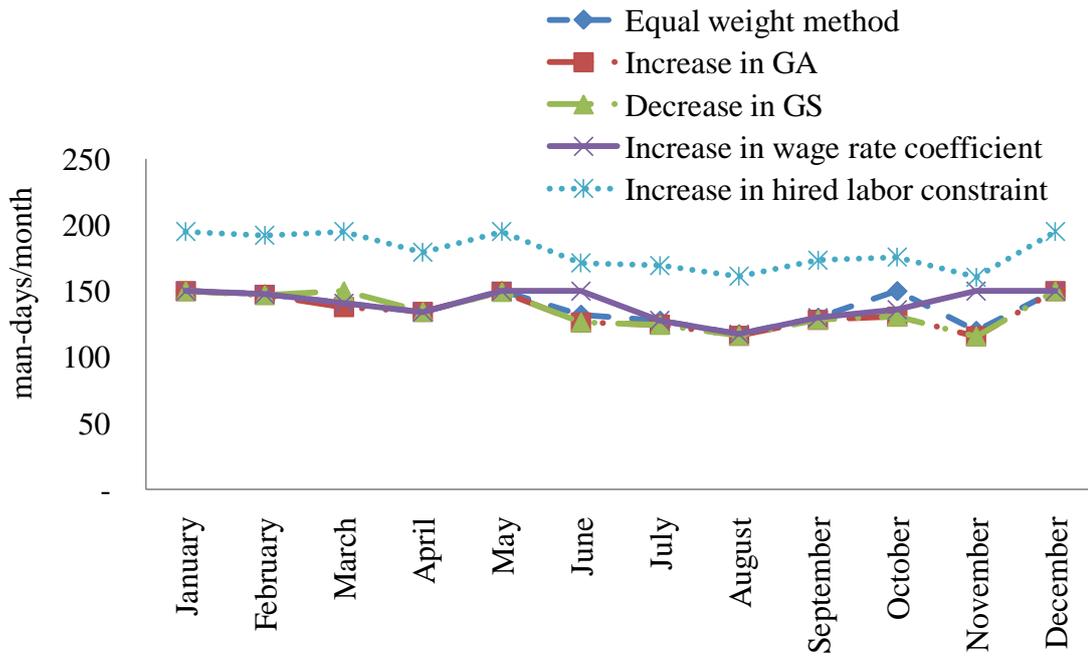


Figure 12.18 Optimal use of hired labor from the sensitivity analysis for the large farms using chemicals and bioextract

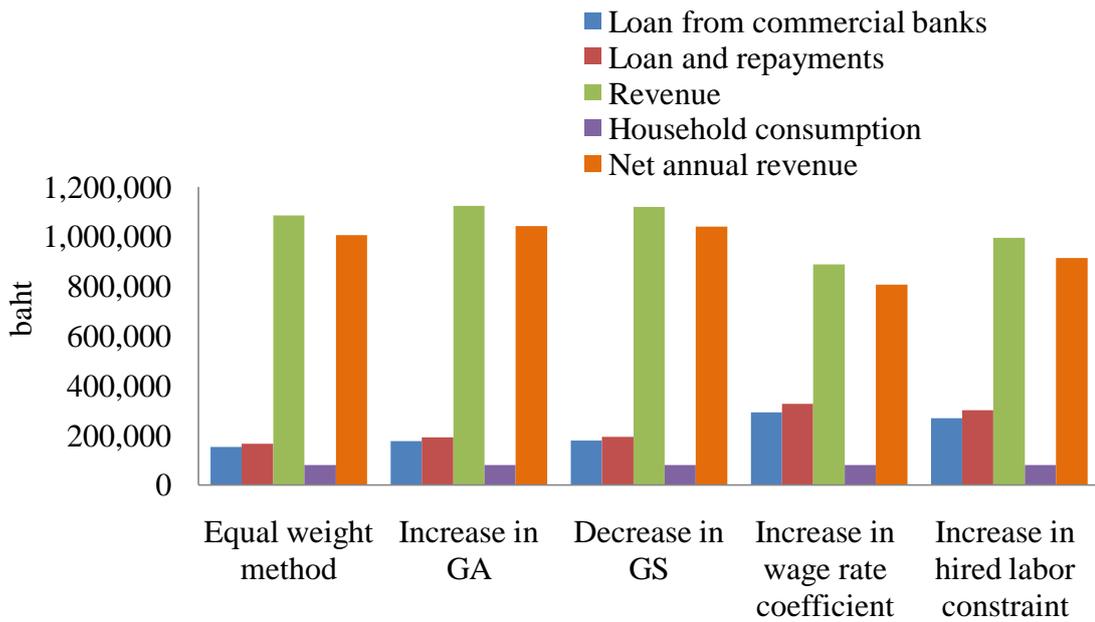


Figure 12.19 Optimal loan management and net annual revenue from the sensitivity analysis for the large farms using chemicals and bioextract

4. Net annual revenue from crop production

The net annual revenue was valued after the loan, interest repayments and household consumption were deducted. The results found that an increase in the annual equivalent value goal (GA) and a decrease in the off-farm work goal (GS) showed a small increase in the net annual revenue compared with the equal weight method results. The increase in the wage rate coefficient and hired labor constraint showed a decrease for the net annual revenue to 806,784 baht and 913,032 baht respectively when compared with the equal weight method results (Figure 12.19).

5. Goal achievement rate

The results found that all the sensitivity analyses gave similar achieved objective goals to the equal weight method results. They were highest for the annual equivalent value (GA) and were lowest for the yield variance (GY) and hired labor (GR).

When comparing between the equal weight method results and the sensitivity analyses goal achievement rate, the results found that an increase in the wage rate coefficient gave the achieved objective goals a similar result to the equal weight method. The other sensitivity analyses showed an increase in the achieved goal of annual equivalent value compared with the equal weight method while the other goals were decreased.

When comparing all the sensitivity analyses, an increase in the wage rate coefficient gave similar results to the equal weight method results. The other sensitivity analyses results varied slightly from the equal weight method results (Figure 12.20)

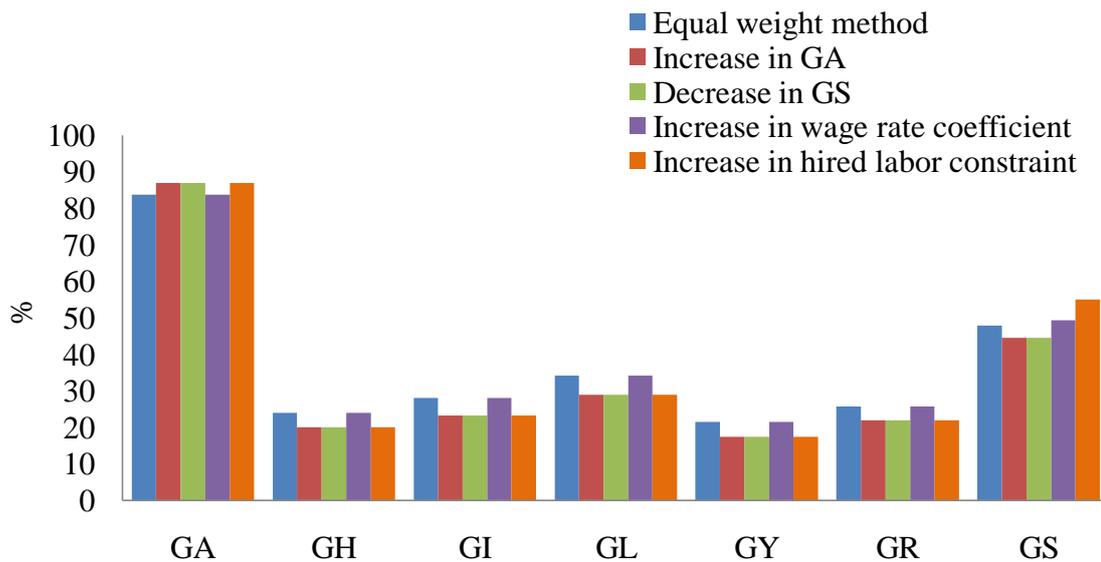


Figure 12.20 Objective goals achieved from the sensitivity analysis for the large farms using chemicals and bioextract

12.2 Results of the sensitivity analyses at the watershed level

This study determined the sensitivity analyses under the set of 3 assumptions which were broken into the 4 situations listed below:

1. Decrease dependence on external inputs by encouraging farmers to adopt the government policy on bioextract. This can be achieved by decreasing the use of chemicals and fertilizer. The chemicals caused symptoms such as vertigo, dizziness, urticaria and skin rashes as well as causing illnesses in the respiratory system. Other causes were related to the musculoskeletal system and connective tissue, digestive system, mouth, skin and subcutaneous tissues.

The chemicals released have polluted the air and water of this area, not only during cultivation but also during the processing of the orange crop, (e.g. water pollution from the cleaning of the orange crop when chemicals are present on the skins). These chemicals are also harmful to the wildlife. In general, orange orchards in the Fang watershed are located on sloping areas which are prone to

soil erosion and soil degradation. The chemical and fertilizer residue left in the soil often leaches and contaminates stream water. Consequently, this affects soil acidity and the soil nutrient balance because of high phosphorus and exchangeable potassium in the soil.

This study sets a possible decrease of 30 percent in the goal of dependence on external inputs (GI) from the equal weight method results. The goal levels used in this analysis were set at 8.75 percent while all the other goals were equal at 13.04 percent.

2. An increase in the revenue from non-timber forest products as approved by government policy. This can be achieved by increasing the forest area as this will increase the habitat of wildlife, water and food stocks. The forest serves the same function as a supermarket for everybody in the rural area as they have easy access to products such as bananas, honey, mushrooms, bamboo shoots and vegetables. The poor people especially harvest the forest for personal consumption and for sale to the wealthier people in their area or nearby communities. This study sets a possible increase of 30 percent in the goal of revenue from non-timber forest products (GF) from the equal weight method results. The goal levels used in this analysis were set at 16.25 percent while all the other goals were equal at 11.96 percent (Table 12.2).

Table 12.2 Goal levels used in the sensitivity analysis at the watershed level

Goals	Equal weight method	GI decrease of 30%	GF increase of 30%
GA	12.50	13.04	11.96
GH	12.50	13.04	11.96
GI	12.50	8.75	11.96
GE	12.50	13.04	11.96
GN	12.50	13.04	11.96
GS	12.50	13.04	11.96
GR	12.50	13.04	11.96
GF	12.50	13.04	16.25
Total	100	100	100

3. A change in the coefficients in input/output tables of activities for optimized resource management at the watershed level. In this study, I determined the following changes to the coefficients:
 - a. An increase in the wage rate coefficient from 200 to 300 baht per day. This increase is due to the government setting a minimum wage for hired labor.
 - b. Increased labor availability due to stronger ties among the *ASEAN Economic Community (AEC)* in 2015. This will result in an increase in the availability of hired labor, as labor from less economically developed countries such as Myanmar and Laos which are close to the Fang watershed, will migrate in search of work. This study increased the hired labor constraint by 30 percent compared to the equal weight method results. This study has allowed for an increase in the maximum number of man-days from 845,425 to 1,099,052 man-days per month for the watershed level.

1. Optimal land use management

The results found that all the sensitivity analyses gave similar results to the equal weight method results which recommended fruit trees for approximately 87 percent of the total area and annual crops for 13 percent.

When we compared the cropping systems for each land unit, all the results from all the sensitivity analyses found that the irrigated upland was optimal for citrus. The irrigated lowland was optimal for coffee at between 208,235 and 231,100 rai and sweet corn followed by sweet corn at between 22,850 and 27,741 rai. The irrigated lowland was optimal for citrus and the rainfed lowland was optimal for rice (Figure 12.21).

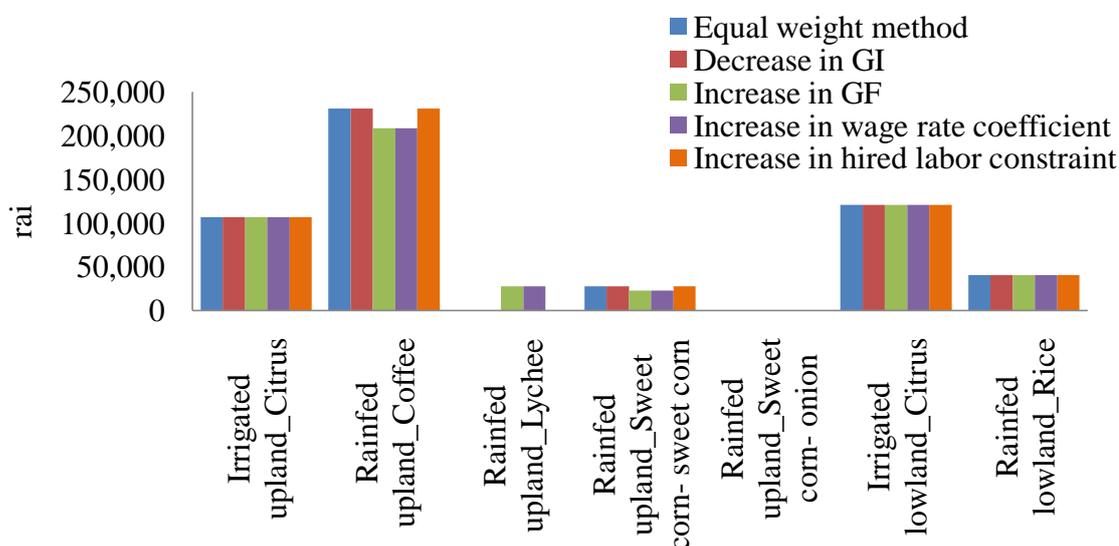


Figure 12.21 Optimal land use management from the sensitivity analysis at the watershed level

2. Off-farm work and hired labor

A decrease in the dependence on the external inputs goal (GI) and an increase in the wage rate coefficient gave the same results for off-farm work as the equal weight method results. The remaining sensitivity analysis results gave a slightly higher result than the equal weight method results (Figure 20.22).

When the hired labor constraint increased by 30 percent, hired labor increased for almost every month which was different from the other sensitivity analysis results. The other sensitivity analysis results were similar to the equal weight method results (Figure 12.23).

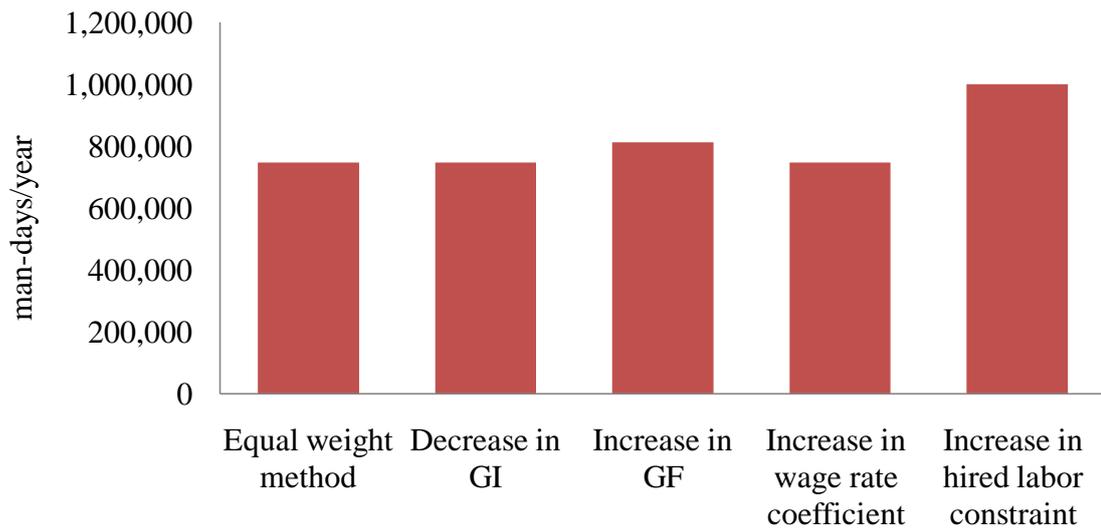


Figure 12.22 Optimal use of off-farm from the sensitivity analysis at the watershed level

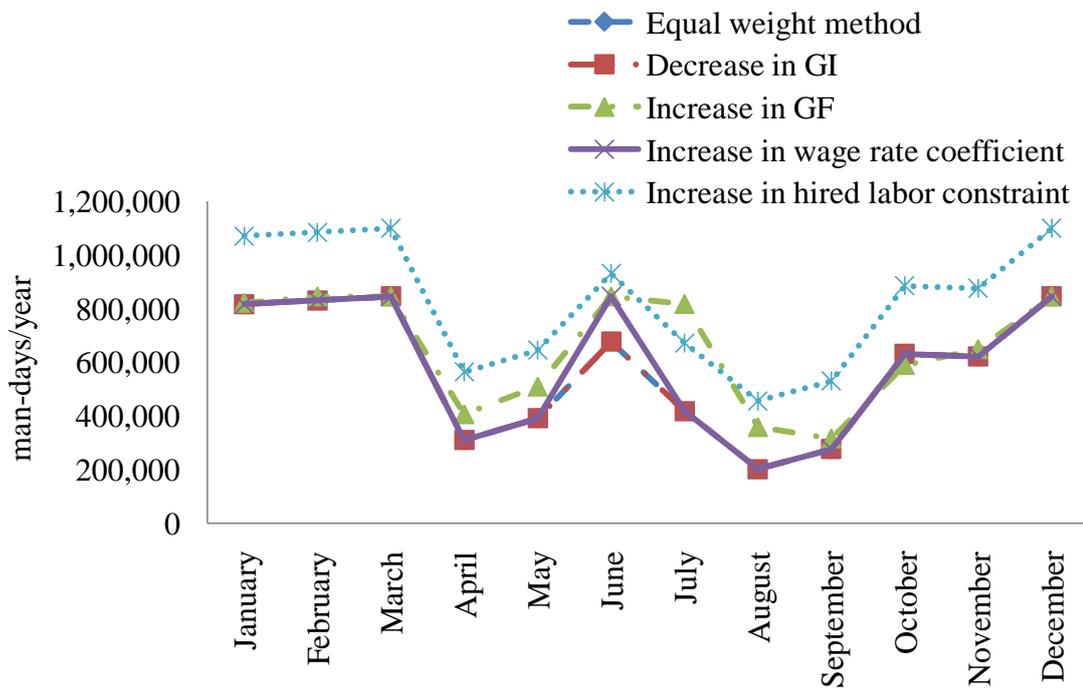


Figure 12.23 Optimal use of hired labor from the sensitivity analysis at the watershed level

3. Loan and repayments

The results found that a decrease in the dependence on the external inputs goal (GI) gave the same loan and repayments as the equal weight method results while an increase in the revenue from the non-timber forest products goal (GF) showed a slight decrease in the loan and repayments to BAAC when compared with the equal weight method results. An increase in the wage rate coefficient and an increase in the hired labor constraint assessed higher loan and repayments than by the equal weight method results (Figure 12.24).

4. Net annual revenue from crop production

The net annual revenue was valued after the loan, interest repayments and household consumption were deducted. The results found that the decrease in the dependence on the external inputs goal (GI) gave the same net annual revenue as the equal weight method results. For the other sensitivity analyses, the results showed a small decrease for the net annual revenue when compared with the equal weight method (Figure 12.24).

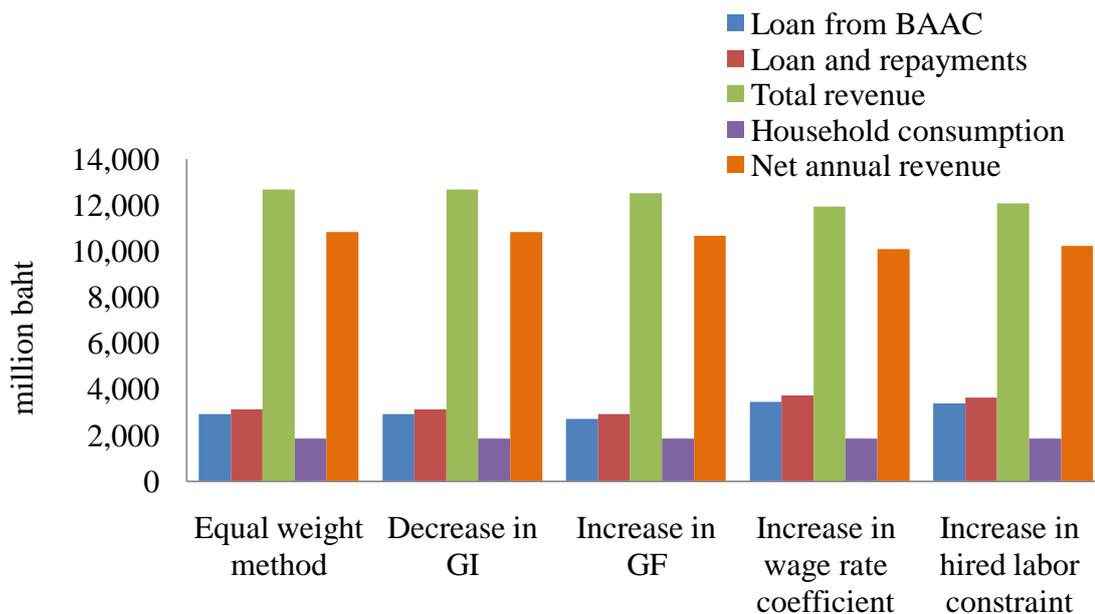


Figure 12.24 Optimal loan management and net annual revenue from the sensitivity analysis at the watershed level

5. Goal achievement rate

The results found that the sensitivity analyses often achieved similar results to the equal weight method results. The greatest changes were seen with the annual equivalent value goal (GA) and the employment goal (GH) whereas the changes were smallest with the revenue variance goal (GR). When comparing between the equal weight method results and the sensitivity analyses goal achievement rate, the results found that all the sensitivity analyses did not vary significantly from the equal weight method results (Figure 12.25)

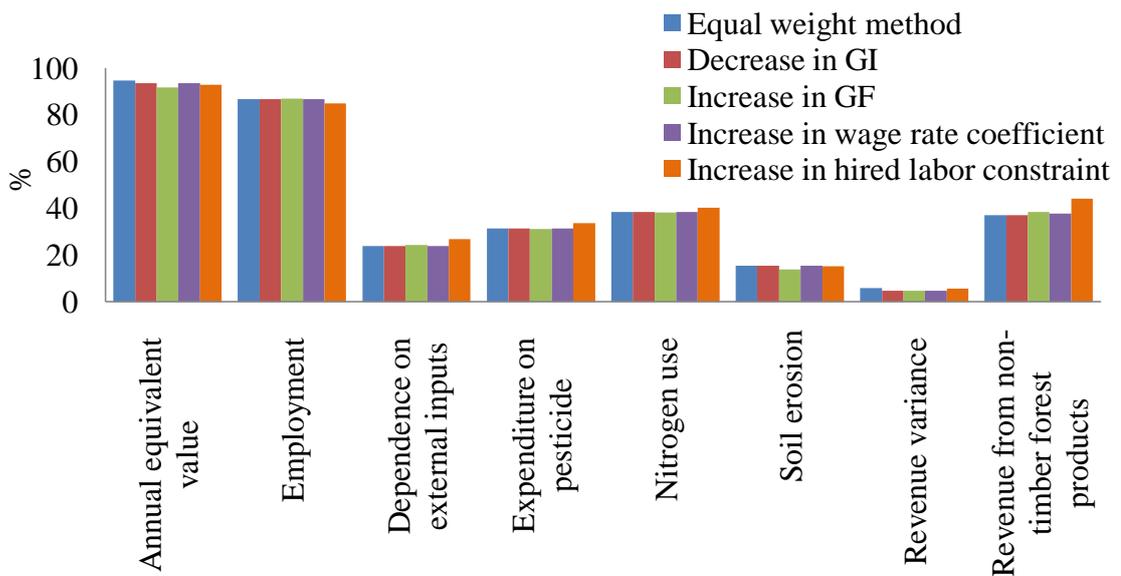


Figure 12.25 Objective goals achieved from the sensitivity analysis at the watershed level

Sensitivity analyses were conducted for 4 situations at both the farm and the watershed level. This compared all the results from the sensitivity analyses with the equal weight method results. These comparisons included land use management, household and hired labor, loan investment, net annual revenue from crop production and the goals achievement rate.