# Chapter 4

# Results

Chapter 4 includes three main parts. The first part describes the resources available and productive activities at farm level. The second part presents results from economical analysis of productive activities. LP model validation results as well as results from different model scenarios are explained in the third part.

## 4.1 General information and resource availability

This part describes general information of farm households derived from the primary data analysis of questionnaire and clarifies several productive activities in the study area (see Table 4.). The information maintained in this part as parameters or constraints was used in Linear Programming Model. The details of each resource are as follows.

**Table 1: General Information for Farm Households from Samples**

| | Mean value | SD[1] |
|---|---|---|
| Average number of family members (person) | 4 | 0.99 |
| Actual labour of engaged in family activity per household (unit: man-day) | 2 | 0.86 |
| Average arable land owned (unit: mu) | 13.5 | 1.85 |
| Average family plots owned before RCFUR (unit: mu) | 12 | 2.8 |
| Average collective forest owned after RCFUR (unit: mu) | 48 | 13.98 |

1 SD is standard deviation

### 4.1.1 Family size and labor

Because of a large population, a long-tem policy called Family Planning Policy provides that only one or two children can be born in one family in China. Due to the policy, there are 4 members in each household at average. Most families contain one or two elderly people, a couple and one or two children.

Since there are older people who often cannot work, children of school age and/or some young family members who are working outside the village, only 40%-45% of the family members are involved in farming activities. The Labour Law regulates that maximum working day per person is 225 man-days per year. The regulation is one constraint for labour used.

Off-farm activities are defined as work during winter months or farming rest months per year, and can not occur during farming busy season (usually from March to June and from August to November). Additionally, women are not usually involved in off-farm activities. Therefore, total time of off-farm activities can not be more than 125 man-days per person.

In terms of off-farm activities, the research only considers short-period off-farm activities. A person who participates in long-term off-farm activities does not live in the village. Usually, children go to urban areas for off-farm jobs, and they send a little money back to their parents. The amount of money coming from children is little and infrequent, so the research considers the remittance as a gift from relations.



### 4.1.2 Education level and knowledge about RCFUR

From surveys, most household heads are male, and their educational levels usually are 7 to 9 years. Their children usually have a higher education level than

them. Many of the second generation have gone outside from the village and lived from off-farm jobs in cities.

In term of the knowledge of RCFUR, every farmer knows the policy and 100% of households have already gotten use right of collective forests and gotten a certification to guarantee their right. It was found that although farmers knew the reform generally, 90% of them don't know the details of the reform, 94% of them have no idea how to use the new rights to improve their well-being and 4% of sample household don't understand the policy at all. All of them expect to get suggestions of how to use land effectively.

### 4.1.3 Land availability

Land in the study area can be distributed in two ways, arable land and forest land. Usually, arable lands are flat lands. In this research, arable lands are defined as lands which are used to plant traditional and annual crops with less than a 15 degree of slope. The study village is located in a mountainous area, so flat lands which are considered arable, are rare. Each household has 13.5 mu arable land and 12 mu forest land (family plots) on average without the RCFUR (see Table 3).

After the RCFUR, use right of collective forest was distributed in each household from the committee of the village. Each household can get at least an additional 48 mu of forest on average. Including the 12 mu family plots, in total, there is an average of 60mu forest which can be used for each household after the RCFUR.

Arable land in the study area is used twice (two planting seasons) per year. In the first season (April to October), also called main season, maize and rice are planted as food crops, as well as feed. Crops in the first season are main crops, which have a

longer growing season and require more input than crops in the second season. In the second season (November to March), wheat and beans are planted instead of fallow.

### 4.1.4 Crop production, silk production and animal husbandry

From surveys and interviews, several farm productions and forest activities were clarified. In the study village, farmers mainly subsist on planting, silk production and animal husbandry. Before the reform of forest use right, forest activities were limited and farmers primarily invested in planting crops. Annual crops were, mainly, maize, rice, wheat, bean and tobacco.

**Maize and rice**: These two crops were traditional food crops, which have been planted since long ago, in the study area. Most maize is used as feed and rice for household consumptions. Sometimes, they sell excess produce or exchange it to get other crops. From the survey, production costs of maize and rice were 405.15 yuan per mu and 422.15 yuan respectively, including seeds, fertilizer, pesticide, plastic covers, machine fees and water fees (sometimes). In terms of labor, planting maize and rice needs 15.27man-days per mu and 14.69man-day per mu respectively.

**Tobacco:** Tobacco leaves can be used to make cigarettes. Cigarette production is one of the key industries in Yunnan province. Tobacco was introduced in the study area as an economical plant to increase farmers' income. After harvesting leaves, farmers dry them, and then sell them to local tobacco collecting stations. Due to high price seeds and high fertilizer and pesticide requirements, planting tobacco has much higher costs than other crops. The excluding labor cost of tobacco is 994.76yuan/mu. When harvesting tobacco leaves, no machine can replace of human, so the labor requirement of tobacco is also high, 37.25 man-day per mu.

**Wheat and beans:** Because the second season is shorter than the first and fertility of soil still strong after the first season, the costs during the second season are less. Wheat is good for keeping soil moisture; meanwhile beans are good for nitrogen fixation. Cost of wheat and beans are 200.55 yuan/mu and 159.15 yuan/mu respectively. Labor needed is also less, 8.93 and 5 man-day per mu respectively.

**Silk:** Silk is a traditional productive in the study area. Farmers plant mulberry trees and collect mulberry leaves to feed silkworms in order to produce silk. Due to limited using right of forests use and managing complications, farmers only planted mulberry trees in arable land before RCFUR. One mu of mulberry tree leaves provide enough food for 2.65 sheet of silkworm, and one sheet of silkworm produces 35kg of silk. Silk production is labor intensive, because it is a complicated and includes a high-technological process from eggs, caterpillars, spinning silk cocoons and moths. Not everybody in a household can raise silkworms. Silk production needs 30 man-day per 2.65 sheets.

**Animal husbandry:** Households raise several kinds of animals, such as chicken, cows and pigs. Chicken fed are just a little, cow used for ploughing land, and only pig are used as a main resource of meat. In the study village, each household raised at least one pig, no matter if it was profitable or not, because it also cultural practice. In the study area, during the period of spring festival, each farm household butchers their own pigs and cooks for a feast to celebrate the most important festival. Another reason pigs are raised is that the study village is far away from the centre of town and time costs and monetary costs for trading is higher than other areas. In addition, nowadays, several food security accidents have happened in China. Some sellers sell meat with unhealthy chemical additive because the meat looks nicer. Farmers think

that quality of pork they produce themselves is guaranteed to be higher quality rather than buying meat. Usually, a pig consumes 700 kg crops (mainly maize) per year. Including input of food, medicine, piglets and so on, the cost of one pig is 646.5 yuan, on average.

### 4.1.5 Forest activities

Before the reform, forests that farmers could use were only family plots (see, chapter 1). Due to many regulations (preventing land trade and logging quotas), limited activities can be done in family plots.

**(1) Pine tree needles collection:** As firewood is needed, the main activity in forests is firewood collection. The main plantation in this area is pine trees, so firewood is usually pine needles and, to a lesser extent, pine tree branches. Pine needles are not used for trading. Farmers pick pine needles for home-consumption.

As firewood, at least 3000 kg pine tree needles are needed for a household per year; meanwhile less than 7000 kg collected does not affect pine tree health.

**(2)Wild mushrooms picking:** Because they are delicious and rare, wild mushrooms find favour with most people in the study area. It was discovered through interviews that local farmers collect mushrooms in the rainy season, not only to sell, but also for household consumption. Each household collected at least 10kg of mushrooms during their growing season. Too much collection will ruin their growing environment to leading to less or no mushrooms the following year. In farmers' experience, the maximum mushrooms that can be collected per mu is 50 kg. In rainy season, wild mushroom collecting can be an important part of farmers' income.

Collecting mushrooms does not require much capital input, but they are difficult to find and is labour intensive, 14 man-day labour needed per mu.

These two activities are primary nowadays. Of course, farmers also need to take care for forests. They need to protect them from pests, fire and other hazards. The cost of management for maintenance costs for pine needle and mushroom collection were included in the study.

During discussions with leaders of the village and expert farmers and consulting experiences of other villages in the same area, the following activities can be done in forests after RCFUR:

**(1) Pine needles and mushroom collection**. These two activities are traditional activities; farmers can continue doing them after RCFUR.

**(2) Pine tree rosin collection:** Main plantations in the study area are pine trees. There are many uses of pine tree. Firstly, rosin can be collected from pine trees. Rosin is an important industrial raw material, and it has a good market prospect. Usually, only pine trees older than 10 years can be used to collect rosin. Meanwhile, this is a highly technical activity and professional workers are needed. If the process is done wrong or too much is collected, pine trees will die. Too much collection also threatens forest health, so the maximum amount of rosin which can be collected, sustainably, is 6 kg per mu.

**(3) Timber extraction**: The trunk of pine trees is good wood for making furniture. Usually, pine trees greater than 20 years old can be cut down. Due to limitations from logging quotas, only 0.23 $m^3$ per household of wood can be cut (see 3.3.2.4).

**(4) Walnut production:** Nowadays, walnut trees have started to increase in popularity. In the area, some villages plant walnut and achieve benefits. Therefore, the study village try to learn experiences from other area, local government introduces and supports farmers to plant walnut as economical trees. The government provides shoots for farmers and send experts to teach farmers how to plant walnut trees.

### 4.2 Economic analysis of productive activities

Gross margins of annual crops and animal husbandry were calculated and discussed here as well as NPV and AEV of forest activities. In addition, family income structure is also presented.

#### 4.2.1. Gross margin analysis

Table 5 shows gross margin of different productions in study village in 2010. Excluding labour cost, every activity earns some money, but when labour cost is included, silk production and collecting mushrooms gets a negative value. The reason could be that the two activities were labour intensive. Collecting mushrooms needs high-labour input, but few people hired labour to do it. Comparing gross margins, bean was higher than others, 1240.85 yuan (excluding labour cost) and 1090.85 yuan (including labour cost).

**Table 2: Gross Margin for Crop Productions, Silk Production and some Forest Activities in Heishui Village in 2010.**

| | Maize | Rice | Tobacco | Wheat | Bean | Silk | Mush-room | Pine needles |
|---|---|---|---|---|---|---|---|---|
| Production cost(yuan/mu) | 405.15 | 422.15 | 994.79 | 200.55 | 159.15 | 187.92 | 25 | 20 |
| Labor needed (man-day/mu) | 15.27 | 14.69 | 37.25 | 8.93 | 5 | 30 | 14 | 2 |
| Labor cost (yuan/mu) | 458.1 | 440.7 | 1117.5 | 267.9 | 150 | 3090 | 140 | 20 |
| Product price (yuan/kg) | 2.6 | 2.86 | 14.74 | 2.3 | 4 | 36 | 20 | 0.05[3] |
| Product yield (kg/mu) | 400 | 350 | 160.38 | 350 | 350 | 92.75 | 5 | 500 |
| Gross revenue (yuan/ mu) | 1040 | 1001 | 2364 | 805 | 1400 | 3339 | 125 | 25 |
| Gross margin excluding labor cost (yuan/ mu) | 634.85 | 578.85 | 1369.21 | 604.45 | 1240.85 | 3151 | 100 | 5 |
| Gross margin including labor cost(yuan/mu) | 176.75 | 138.15 | 251.71 | 336.55 | 1090.85 | 61.08 | -40 | -15 |

Note:

1. Labour costs for crop production are 30 yuan/man-day and for forest activities are 50 yuan/man-day.
2. Silk production costs involve two parts. One is the cost of planting mulberry, the other is feeding silkworms. From interviews, it is known that 1 mu mulberry leaves can feed 2.65 sheets of silkworms. 1 sheet of silkworms produces 35kg silk on average.
3. In the study area, farmers never trade pine needles. The price of pine needles comes from farmer estimates.

Table 6 shows the gross margin of raising pigs. The gross margin, excluding labour and including labour, is -366.15 yuan/head and -1126.15 yuan/head respectively. Farmers grow maize to feed pigs. This leads to costly pig production.

**Table 3: Gross Margin for Animal Husbandry in Heishui Village in 2010.**

| Items | Pig |
|---|---|
| Production cost (yuan/head)[1] | 646.5 |
| Own maize consumed (yuan/head) | 1820[3] |
| Labour needed (man-day/head) | 8 |
| Labour cost (yuan/head) | 760 |
| Product price(yuan/kg)[1] | 17.65 |
| Product yield(kg/head) | 119 |
| Gross revenue (yuan/head) | 2100.35 |
| Gross margin excluding labor cost (yuan/head) | -366.15 |
| Gross margin including labor cost(yuan/head) | -1126.15 |

Note: 1. Average weight of pigs at 119 kg.

2. Labour price for animal husbandry is 90 yuan/man-day.

3. 700 kg maize is needed to feed one pig.

### 4.2.2 Net Present Value and Annual Equivalent Value of forest activities

After the reform, more forestry production can be done. There is pine tree rosin collection, timber extraction and walnut tree planting. All of these three activities are long-tem investment, so NPV methods were used to calculate benefits and costs of them. Table 7 shows that the result of NPV and AEV of new forestry productions after RCFUR.

**Table 4: Cost and Labour Used per mu of New Forest Productions after the RCFUR**

| | Rosin | | | | | Timber extraction | | | | | Walnut | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Output (yuan) | Cost (yuan) | Labor (man-day) | Benefit excluding labor cost[4] (yuan) | Benefit including labor cost[5] (yuan) | Output (yuan) | Cost (yuan) | Labor (man-day) | Benefit excluding labor cost[4] (yuan) | Benefit including labor cost[5] (yuan) | Output (yuan) | Cost (yuan) | Labor (man-day) | Benefit excluding labor cost[4] (yuan) | Benefit including labor cost[5] (yuan) |
| 1 | 0 | -142.5 | 3 | -142.5 | | 0 | -142.5 | 8 | -142.5 | | 0 | -453.33 | 40 | 453.33 | -1546.67 |
| 2 | 0 | -50 | 1 | -50 | | 0 | -50 | 4 | -50 | | 0 | -368.33 | 35 | 368.33 | -1381.67 |
| 3 | 0 | -50 | 1 | -50 | | 0 | -50 | 4 | -50 | | 0 | -368.33 | 35 | 368.33 | -1381.67 |
| 4 | 0 | -25 | 0.5 | -25 | | 0 | -25 | 3 | -25 | | 0 | -368.33 | 20 | 368.33 | -631.67 |
| 5 | 0 | -25 | 0.5 | -25 | | 0 | -25 | 3 | -25 | | 0 | -368.33 | 20 | 368.33 | -631.67 |
| 6 | 0 | -25 | 0.5 | -25 | | 0 | -25 | 2 | -25 | | 480 | -300 | 20 | 780 | -220 |
| 7 | 0 | -25 | 0.5 | -25 | | 0 | -25 | 2 | -25 | | 1344 | -300 | 25 | 1644 | 394 |
| 8 | 0 | -25 | 0.5 | -25 | | 0 | -25 | 2 | -25 | | 2208 | -300 | 25 | 2508 | 1258 |
| 9 | 0 | -25 | 0.5 | -25 | | 0 | -25 | 2 | -25 | | 3072 | -300 | 30 | 3372 | 1872 |
| 10 | 1470 | -588 | 3.5 | 882 | | 0 | -25 | 2 | -25 | | 3296 | -300 | 30 | 3596 | 2096 |
| 11 | 1470 | -588 | 3.5 | 882 | | 0 | -25 | 2 | -25 | | 3840 | -300 | 30 | 4140 | 2640 |
| 12 | 1680 | -672 | 4 | 1008 | | 0 | -25 | 2 | -25 | | 4800 | -300 | 35 | 5100 | 3350 |
| 13 | 1680 | -672 | 4 | 1008 | | 0 | -25 | 2 | -25 | | 5760 | -300 | 35 | 6060 | 4310 |
| 14 | 1680 | -672 | 4 | 1008 | | 0 | -25 | 2 | -25 | | 6400 | -200 | 30 | 6600 | 5100 |
| 15 | 1680 | -672 | 4 | 1008 | | 0 | -25 | 2 | -25 | | 6400 | -200 | 30 | 6600 | 5100 |
| 16 | 1680 | -672 | 4 | 1008 | | 0 | -25 | 2 | -25 | | 6400 | -200 | 30 | 6600 | 5100 |
| 17 | 1680 | -672 | 4 | 1008 | | 0 | -25 | 2 | -25 | | 6400 | -200 | 30 | 6600 | 5100 |
| 18 | 1890 | -756 | 7 | 1134 | | 0 | -25 | 3 | -25 | | 6400 | -200 | 30 | 6600 | 5100 |
| 19 | 1890 | -756 | 7 | 1134 | | 0 | -25 | 3 | -25 | | 6400 | -200 | 35 | 6600 | 4850 |
| 20 | 1890 | -756 | 7 | 1134 | | 10400 | -3275 | 9 | 7125 | | 6400 | -200 | 35 | 6600 | 4850 |
| NPV[1] | 10361.29 | -4488.72 | | 5872.57 | | 4746.42 | -1981.34 | | 2765.09 | | 16350.81 | -3381.62 | | 19732.44 | 5119.69 |
| AEV[1] | 762.4018 | -330.28 | 3 [2] | 432.11 | 282.11 | 349.25 | -145.79 | 3.05 [2] | 203.46 | 50.96 | 1203.12 | -248.76 | 30 [2] | 1451.95 | -48.05 |

Note:

1. Discount Rate used to calculate NPV and AEV is 0.04 which is five-year Lump-sum Time deposit rate (2010-10-20).
2. Labour used for each activity was calculated as a average value. The average price of labour for forest activities is 50 yuan/man-day.
3. Benefit excluding labour cost in an average year = AEV of output – AEV of production cost
4. Benefit including labour cost in an average year = AEV of benefit excluding labour cost – average labour using × labour price
5. Unit of output, cost and benefit of each activity is yuan/mu. Unit of labour of each activity is man-day/mu.
6. Because these productions (including pine tree rosin collection, timber extraction and walnut tree planting) haven't been done in the study area yet, information about them is theoretical value or practical value from neighbouring areas and statistical data.

Table 7 illustrates that every production earns money excluding labour cost by AEV value. Walnut tree production earns highest, which is 1451.95 yuan/mu. However, due to high labour use (30 man-day), walnut tree production doesn't earn profit with labour costs, (-48.05 yuan/mu). In the situation of benefit including labour cost, pine tree rosin collection earns the highest income, (282.11 yuan/mu). The table also indicates that new productions create new way to earn money, but benefits are so few that they do not contribute significantly to family income.

### 4.2.3 Family income structure in average level

Figure 5 shows that there were four main productions that make up household income in 2010.

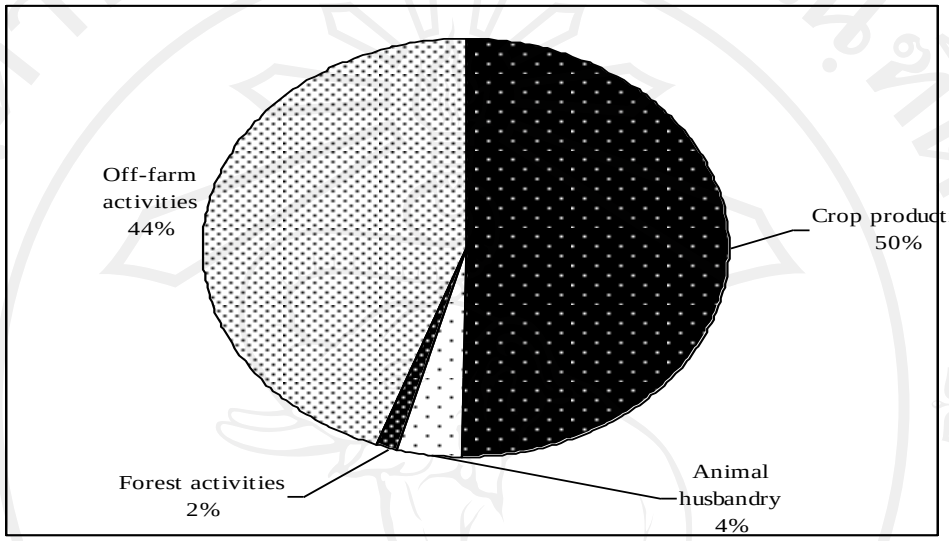


**Figure 5: Family Income Structures in Average Level in Heishui Village in 2010.**

In 2010, family income mainly came from crop production, animal husbandry, forest and off-farm activities. Crop production and off-farm activities were the main source of income, 48% and 44% respectively. Forest activities only provide 1% of total income.

### 4.3 Impact analysis

#### 4.3.1 Validation of Linear programming model

The basic model needs to be tested to see whether it is suitable for future scenario testing. The results of the basic model were compared to actual farmers' practises which came from the survey result.

**Total family net income**: Table 8 illustrates that the average net household income, from the surveys, is almost the same as the result from the Baseline. The result from surveys was 1% lower than Baseline.

**Net income of crop production** from the Baseline is higher 1% than from the surveys. The reasons can be seen in Table 9. Tobacco and rice production are very costly with little benefit (see Table 5). In order to maximize income, the model suggests growing less rice and tobacco. But, in practise, planting rice is a traditional practice. Farmers used to plant rice, no matter whether they earn a profit or not. For tobacco, in the past, it was one of the key income resources of farmers, and the government encouraged farmers to plant it. Nowadays, the benefits from tobacco continue to decrease as fewer people smoke, but farmers are accustomed to planting it. Therefore, farmers still plant rice and tobacco. Before 2010, the price of bean was not as good as in 2010 when it suddenly went up. As a result, the model shows increased planting, whereas, previously, farmers didn't know the good marketing prospect and didn't plant much. The model suggests planting much more maize. One reason is that maize is a main resource to feed pigs, and each household must keep at least one pig. Thus, it is necessary to plant maize. The other reason is due to the different combinations of enterprises between the model and the survey results. Maize is planted in the same season (April to October) with less cost than rice and tobacco. In order to best use land, the model suggests planting more maize rather than tobacco and rice.

**Net income of animal husbandry**: Table 8 shows that the result of Baseline model is higher than surveys. In the model, only 2.75 sheets of silkworm were suggested, but farmers fed much more than that in practice (see Table 7). From gross

margin analysis, it is seen that the ability to earn money is not as good as with other productions (see Table 5). Thus, the result of survey is lower than the model.

**Net income of forestry and off-farm activities**: The result from the model is lower than the surveys' result. The differences are 5% and 3% respectively. From the surveys, farmers mentioned some occasional income from the forest. For example, sometimes, when farmers went to collect pine needles, they found wild orchids and sold them in markets. This is occasional income, which is impossible to show in the LP model. For off-farm activities, this is mainly due to the fact that remittance was excluded in the basic model. Some family members do off-farm jobs outside of the village for a long time and send money back to the family. Farmers still think this is off-farm income, but the research didn't account for this in the model.

**Table 5: Comparison of Net Income of Main Productions between Baseline Scenario and the Surveys in Heshui Village**

| Net income [yuan] | Surveys | Baseline | Difference (%) |
|---|---|---|---|
| 1)Crop production | 14617.46 | 15268.02 | 4% |
| 2)Animal husbandry | 1131.50 | 1258.65 | 11% |
| 3)Forest activities | 438.87 | 416.94 | -5% |
| 4)Off-farm activities | 12877.81 | 12500.00 | -3% |
| Total income from main productions= Sum (1-4) | 29065.64 | 29443.61 | 1% |

**Table 6: Results on Resource Used and a Combination of Farm Enterprise from the Baseline Scenario and Surveys in Heshui Village**

| Items | Survey | Baseline | Difference |
|---|---|---|---|
| Land use (mu) | | | |
| - Maize | 1.3 | 7.96 | 6.66 |
| - Rice | 4.3 | 0.68 | -3.62 |
| - Wheat | 1.08 | 0 | -1.08 |
| - Tobacco | 2.83 | 0.09 | -2.74 |
| - Bean | 6 | 8.73 | 2.73 |
| Silkworm (sheet) | 10.58 | 2.75 | 7.83 |
| Pig (head) | 3 | 1 | -2 |

In summary, all differences of each item are less than 20%. The baseline model is close enough to the actual farmers' practices. The model produces overestimated results as it assumes the perfect knowledge on the part of farmers and decisions are made suddenly which is different from the reality. Consequently, these baseline models are used as a basis for other scenarios.

### 4.3.2 The impact of the tested scenarios

Model results were interpreted based on different model scenarios. Including the baseline scenario, there were five scenarios being analyzed after the model was validated (see 4.3.1). The model results of the tested scenarios are used to compare with the results from baseline scenarios. The differences between both results are interpreted as the impact of the tested scenarios.

#### 4.3.2.1 Impact of the Reform of Collective Forest Use Right

Baseline is a model which simulates farmers' activity without the reform of RCFUR; meanwhile Scenario 1a is with the RCFUR (for detail to see 3.2.4)

The comparison of net income in each income category is calculated from solution and price vectors in the LP model, shown in Table 10.

From comparisons in Table 10, total net family income of Scenario 1a is 30638.66 yuan, which is 1855.22 yuan more than the baseline scenario. There is an increase of 6.45%. After comparing the net income in each category, it is shown that the differences came from crop production and forest activities, whereas for other income categories the results were almost the same. Income differences from crop production

are 1329.08 yuan. The greatest increase occurs in forest activities' income, 93.33%, which means farmers' incomes will go up with RCFUR.

**Table 7: Net Incomes Comparison between Baseline Scenario and Scenario 1a**

| Net income [yuan] | Baseline | Scenario 1a | Difference (%) |
|---|---|---|---|
| 1)Crop production = | 15268.02 | 16597.10 | 1329.08 (8.70%) |
| + output value of crops sold | 20261.67 | 21982.42 | 1720.75 |
| + output value of crops consumed | 0.00 | 0.00 | 0.00 |
| - input value of crop production | 4993.65 | 5385.32 | 391.68 |
| 2)Animal husbandry and silk production = | 3082.65 | 3082.65 | 0.00 (0%) |
| + output value of meat and silk sold | 9579.03 | 9579.03 | 0.00 |
| + output value of meat consumed | 1824.00 | 1824.00 | 0.00 |
| - input value of animal husbandry and silk production | 8320.37 | 8320.37 | 0.00 |
| 3)Forest activities = | 563.76 | 1089.00 | 525.24 (93.17%) |
| + output value of forest products sold | 781.29 | 1229.43 | 448.14 |
| + output value of forest products consumed | 146.82 | 150.00 | 3.18 |
| - input value of forest activities | 364.35 | 290.43 | -73.92 |
| 4)Off-farm activities | 12500.00 | 12500.00 | 0.00 |
| 5)Credit | -631.00 | -631.00 | 0.00 |
| 6)Cost of food bought | -2000.00 | -2000.00 | 0.00 |
| **Total net family income (yuan) = Sum(1-6)** | **28783.43** | **30637.75** | **1854.32 (6.44%)** |

Table 11 and 12 demonstrate that both without the RCFUR and with the RCFUR, the arable land is fully used, which is 13.5 mu. Because maize and beans require low cost and less labour. Scenario 1a suggests to only growing maize in the first season (from April to Oct.) and only beans in the second season (from Nov to Feb). Both of them are grown 9.54 mu. For forest land, although income of forest activities

increases, the Scenario 1a suggests that only 6.7 mu are used for developing forest production by farmer themselves, which is less than Baseline, as most land is still rented out. This means that the main reason for increased income from forestry is that a lot of forest land is rented out. However, more pine needles are collected in Scenario 1a, on the contrary, collecting mushroom is less.

**Table 8: Main Resource Used by Baseline and Scenario 1a**

| | Baseline | | Scenario 1a | |
|---|---|---|---|---|
| | March to Oct. | Nov. to Feb. | March to Oct. | Nov. to Feb. |
| Total arable land used [mu]= | 13.50 | 13.50 | 13.50 | 13.50 |
| +Arable land used for crops | 8.73 | 8.73 | 9.54 | 9.54 |
| + Arable land rented out | 3.39 | 3.39 | 2.58 | 2.58 |
| + Mulberry tree | 1.37 | 1.37 | 1.37 | 1.37 |
| Forest land used | | 7.81 | | 6.70 |
| Forest land rent out | | 0.00 | | 48.00 |
| Total labor used [man-day] = | | 537.30 | | 537.32 |
| + Labor used in crop production | | 178.64 | | 193.44 |
| + Labor used in forest activities | | 126.28 | | 111.50 |
| + Labor used in animal husbandry | | 7.10 | | 7.10 |
| + Labor used in silk production | | 100.27 | | 100.27 |
| + Labor used in off-farm activities | | 125.00 | | 125.00 |
| + Labor hired | | 37.30 | | 37.32 |

In terms of labour, labour has been fully used in Baseline and more labour is required. Farmers must hire an additional 37.3 man-day. In Scenario 1a, hired labour is 37.32 man-day, only 0.02 more than Baseline. However, the labour using structure is totally different. Much more labour used in crop production, less in forest activities. Labour input for off-farm activities, animal husbandry and silk production are the same between both scenarios.

**Table 9: Activities Selected by Baseline and Scenario 1a**

| Activities and resources | Baseline | Scenario 1a | Difference |
|---|---|---|---|
| Crop selected [mu] | | | 1.62 |
| Grow maize | 7.96 | 9.54 | 1.58 |
| Grow rice | 0.68 | 0.00 | -0.68 |
| Grow tobacco | 0.09 | 0.00 | -0.09 |
| Grow wheat | 0.00 | 0.00 | 0.00 |
| Grow bean | 8.73 | 9.54 | 0.81 |
| Forest activities [mu] | | | -0.99 |
| Collecting pine needles | 5.87 | 6.00 | 0.13 |
| Collecting mushroom | 7.81 | 6.68 | -1.14 |
| Collecting pine tree rosin | 0 | 0.00 | 0.00 |
| Timber extract | 0 | 0.02 | 0.02 |
| Grow walnut | 0 | 0.00 | 0.00 |
| Animal selected | | | |
| Pig fed [head] | 1.00 | 1.00 | 0.00 |
| Silk production [sheet] | 7.28 | 7.28 | 0.00 |

***Shadow price analysis***

***1. Baseline***

In excel solver, shadow prices of linear programming problem are calculated as Lagrange multiplier. This part will analyze different constraints' shadow price to learn that how different recourses affect the objective value.

The highest values of shadow price of all constraints were for the minimum number of pigs fed. It is negative, which means that number of pigs fed had a negative preference for total farm income. Increasing one unit pig, the total income will be reduced to 1296.51yuan (see Table 13). From gross margin analysis, feeding pigs is

very costly and less profitable in the study area. The model doesn't recommend pig production.

Land is another important constraint. The Lagrange Multiplier of area of arable land from November and March is positive and very large. With an increase of one mu of arable land, the total income can increase by 1024.23 yuan (see Table 13). In contrast, the result of changes in arable land in another season (from April to Oct.) is negative. One more mu added will lead to a reduction in total income. The reason leading to both of these two changes is due to the beneficial ability of different crops. Beans, which are grown from Nov. to Feb. has high potential to earn money, but rice and tobacco are very costly. The model recommends that more land should be used in the second season.

In terms of labor, off-farm activity limitations have high shadow prices (see Table 13). Since off-farm activities are highly profitable, the model would like to suggest more off-farm activities. But in practice, farmers only use the rest time to do off-farm activities. The main business still is farm production. The result may show a tendency ----- more and more second generation children of farmers go outside the village to get education or to do off-farm jobs. Most of them don't come back and live in the village anymore.

With relation to money, increasing 1 unit to credit and saving will create 1.69 and 1.61 more credit units of total family income, respectively. Even though the change is small, it is apparent that more capital input is expected.

**Table 10: Shadow Prices of Several Constraints in Baseline**

| Items | Final value | Lagrange Multiplier/shadow price |
|---|---|---|
| Arable land available from April. to Oct. [mu] | 13.50 | -422.89 |
| Arable land available from Nov. to March. [mu] | 13.50 | 957.37 |
| Labor available [man-day] | 500.00 | 3.45 |
| Labor limitation of off-farm [man-day] | 125.00 | 96.55 |
| Number of pig fed [head] | 1.00 | -1124.03 |
| Saving limitation[yuan] | 3000.00 | 1.69 |
| Credit limitation[yuan] | 10000.00 | 1.61 |

***2. Scenario 1a***

In scenario 1a, arable land in the second season still is a rare resource, which is a highly important factor, Lagrange Multiplier is 890.65 (see Table 14). But, in comparison with Baseline, the impact decreases. It can be explained that there is other income from forest, so arable land is not as important as in Baseline.

For monetary capital, adding one more unit to credit and saving, the total family income will increase 2.17 and 2.09 respectively. Credit and saving has a higher shadow price than the Baseline model. With the RCFUR, more activities can be done in forest, yet at the same time, farmers need more capital for forest investment.

**Table 11: Shadow Prices of Main Resources in Scenario 1a**

| Item | Final value | Lagrange Multiplier/shadow price |
|---|---|---|
| Arable land available from Apr. to Oct. [mu] | 13.50 | -260.22 |
| Arable land available from Nov. to March. [mu] | 13.50 | 890.65 |
| Labor available[man-day] LHS | 500.00 | 1.51 |
| Labor limitation of off-farm [man-day] | 125.00 | 98.49 |
| Saving limitation[yuan] | 3000.00 | 2.17 |
| Credit limitation[yuan] | 10000.00 | 2.09 |
| Number of pig fed [head] | 1.00 | -2036.43 |

In Table 15, most constraints of new productions have no impact. Only for timber extraction, log quotas limit trees cutting, only 0.23 $m^3$ woods per mu can be cut. The shadow price shows that if log quotas can widen, more trees can be cut, and the family income will increase. Therefore, Scenario 4 (logging quotas changing) will test this situation.

**Table 12: Shadow Prices of New Forest Productions in Scenario 1a**

| Item | Final value | Lagrange Multiplier/shadow price |
|---|---|---|
| Area for mushroom [mu] | 54.69 | 0.00 |
| Area for resin [mu] | 0.00 | 0.00 |
| Area for timber [mu] | 0.02 | 0.00 |
| Area for walnut tree [mu] | 0.00 | 0.00 |
| Log quotas [m3] | 0.23 | 301.65 |
| Limitation of forest land rented out [mu] | 48.00 | 31.52 |

The model suggests more land should be rented out. The result indicates that only giving more rights to increase productions in forests is not enough to support farmers' well-being. Because more technology and capital is needed, it is still difficult to develop new forest production for farmers without other support systems.

**4.3.2.2. Implement of Reform of Collective Forest Use Right with Sloping Land Conversion Program**

Scenario 2 demonstrates that farmers' activities, based on the impact of both reform of RCFUR and another policy of SLCP (detail to see 3.2.4).

In order to test different impacts of transferring area, three runs were tested, one is change 3 mu arable land to forest (Scenario 2a(3 mu)), another is transfer 4 mu (Scenario 2a(4 mu)), third is transfer 2 mu (Scenario 2a(2mu)).

**Table 13: Net Incomes Comparison between Scenario 1a, and Scenario 2a.**

| | Scenario 2a (4mu) | | Scenario 2a (3mu) | | Scenario 2a (2mu) | |
|---|---|---|---|---|---|---|
| Income category | Value | Diff (%)[1] | Value | Diff (%)[1] | Value | Diff (%)[1] |
| 1)Crop production | 13422.64 | -19% | 14685.36 | -12% | 15322.61 | -8% |
| 2)Animal husbandry and silk production | 3082.65 | 0.00 | 3082.65 | 0.00 | 3082.65 | 0.00 |
| 3)Forest activities | 1589.19 | 46% | 1204.00 | 11% | 1165.67 | 7% |
| 4)Off-farm activities | 12500.00 | | 12500.00 | | 12500.00 | |
| 5)Credit | -631.00 | | -631.00 | | -631.00 | |
| 6)Cost of food bought | -2000.00 | | -2000.00 | | -2000.00 | |
| 7)SLPC subsidy | 2400.00 | | 1800.00 | | 1200.00 | |
| 8)Forest credit | 0.00 | | 0.00 | | 0.00 | |
| Total net family income (yuan) = sum(1-8) | 30363.48 | -274.27 (-1%) | 30641.02 | 3.26 (0%) | 30639.93 | 2.18 (0%) |

Note: 1. Difference from Scenario 1a.

In Table 16, total family net income goes down in Scenario 2a (4mu), but values of Scenario 2a (3 mu) and Scenario 2a (2 mu) are almost the same as Scenario 1a. This scenario illustrates that in order to protect the environment and avoid soil erosion; farmers can change 3mu or 2mu arable land to forest, which will not impact farmers' well-being. Compared with 2 mu, 3 mu earns a tiny bit more money. However, and increase to 3 mu arable land leads to a family income decrease. There is a 1% reduction of total family income, when 4 mu arable lands are changed into forest.

Table 17 shows that main resources used in two tests.

**Table 14: Main Resource Used in Scenario 2a(4 mu) and Scenario 2a (3 mu)**

| | Scenario 2a(4mu) | | Scenario 2a(3mu) | |
|---|---|---|---|---|
| Land [mu] | March - Oct. | Nov. - Feb. | March - Oct. | Nov. - Feb. |
| Total arable land used= | 9.50 | 9.50 | 10.50 | 10.50 |
| +Arable land used for cropping | 8.13 | 8.13 | 8.76 | 8.76 |
| +Arable land rented out | 0.00 | 0.00 | 0.37 | 0.37 |
| mulberry tree | 1.37 | 1.37 | 1.37 | 1.37 |
| Forest land used | 8.64 | | 7.83 | |
| Forest land rent out | 52.00 | | 51.00 | |
| Total labor used [man-day] = | 537.71 | | 537.32 | |
| +Labor used in crop production | 164.72 | | 177.58 | |
| +Labor used in forest activities | 140.61 | | 127.37 | |
| +Labor used in animal husbandry | 7.10 | | 7.10 | |
| +Labor used in silk production | 100.27 | | 100.27 | |
| +Labor used in off-farm activities | 125.00 | | 125.00 | |
| Hired labor | 37.71 | | 37.32 | |

In Table 17, it can be seen that more forest land was used and more labour was used in forest activities in Scenario 2a (4 mu) than Scenario 2a (3 mu), but the total income is less. The ability to earn money from forest activities is still weaker than for traditional crop production.

***Shadow price analysis***

Because this scenario tested model changing during arable land changing, shadow prices of arable land will be carefully observed.

Table 18 shows that reducing arable land to 3 mu has no impact, the shadow price of arable land is same with Scenario 1a. But, the condition is very different when 4 mu arable lands are changed into forest lands. Arable lands turn into a rare resource. Adding one unit arable land leads to a large increase in total income. The results indicate that SLCP can be carried out in the study village, but on average, only 3 mu arable lands for each household can be transferred to forest land.

Because the constraint of arable land from April to Oct requires farmers use all arable land, the shadow price of arable land from April to Oct. is minus.

**Table 15: Shadow Prices of Main Resources in Scenario 1a and Scenario 2a**

| Items | Shadow price of Scenario 1a | Shadow price of Scenario 2a (3mu) | Shadow price of Scenario 2a (4mu) |
|---|---|---|---|
| Arable land available from April to Oct. [mu] | -260.22 | -260.22 | 127.16 |
| Arable land available from Nov. to March [mu] | 890.65 | 890.65 | 1044.70 |

**4.3.2.3. Impact of Reform of Collective Forest Using Right and planting mulberry tree in forest land**

Scenario 3 is a model which supposes farmers plant mulberry in forest land instead of arable land.

Comparing with Scenario 1a, net family income of Scenario 3a is almost same, even 12.48 yuan less (See Table 19). Mulberry trees themselves are perennial plantation. They match being planted in forest. Planting mulberry trees in forest, more arable lands are saved to plant other crops. However, planting mulberry trees in forests needs more inputs and labours, so high cost of mulberry trees leads income of animal husbandry and silk production decrease (see Table 19).

**Table 16: Net Incomes Comparison between Scenario 1a, and Scenario 3a**

| Income category [yuan] | Scenario 1a | Scenario 3a | Difference (%) |
|---|---|---|---|
| 1) Crop production | 16597.10 | 16905.69 | 308.60 (2%) |
| + output value of crops sold | 21982.42 | 22302.42 | 320.00 |
| + output value of crops consumed | 0.00 | 0.00 | 0.00 |
| - input value of crop production | 5385.32 | 5396.73 | 11.41 |
| 2) Animal husbandry and silk production | 3082.65 | 2807.93 | -274.73(-9%) |
| + output value of meat and silk sold | 9579.03 | 9579.03 | 0.00 |
| + output value of meat consumed | 1824.00 | 1824.00 | 0.00 |
| - input value of animal husbandry and silk production | 8320.37 | 8595.10 | 274.73 |
| 3) Forest activities | 1089.00 | 1042.65 | -46.35 (-4%) |
| + output value of forest products sold | 1229.43 | 1167.63 | -61.80 |
| + output value of forest products consumed | 150.00 | 150.00 | 0.00 |
| - input value of forest activities | 290.43 | 274.98 | -15.45 |
| 4) Off-farm activities | 12500.00 | 12500.00 | 0.00 |
| 5) Credit | -631.00 | -631.00 | 0.00 |
| 6) Cost of food bought | -2000.00 | -2000.00 | 0.00 |
| Total net family income = sum(1-6) | 30637.75 | 30625.28 | -12.48 (0%) |

**Table 17: Activities Selected by Scenario 1a and Scenario 3a**

| Activities and resources | Scenario 1a | Scenario 3a | Difference |
|---|---|---|---|
| Crop selected [mu] | | | |
| Grow maize | 9.54 | 9.56 | 0.02 |
| Grow rice | 0.00 | 0.00 | 0.00 |
| Grow tobacco | 0.00 | 0.00 | 0.00 |
| Grow wheat | 0.00 | 0.00 | 0.00 |
| Grow bean | 9.54 | 9.56 | 0.02 |
| Forest activities [mu] | | | |
| Collecting pine tree needles | 6.00 | 6.00 | 0.00 |
| Collecting mushroom | 6.68 | 6.06 | -0.62 |
| Collecting pine tree rosin | 0.00 | 0.00 | 0.00 |
| Timber extract | 0.02 | 0.02 | 0.00 |
| Grow walnut | 0.00 | 0.00 | 0.00 |
| Animal selected | | | |
| Pig fed [head] | 1.00 | 1.00 | 0.00 |
| Silk production [sheet] | 7.28 | 7.28 | 0.00 |

After planting mulberry trees on forest lands, more arable land were used for planting and renting out (see Table 21). There are more 0.02 mu used for planting, which used to planting maize and bean (see Table 20). More forest lands also are used for production. Table 21 shows that there is more 2.13 mu forest land using for forest activities instead of renting out, but most of these forest lands were used for planting mulberry trees, table 20 shows that forest lands used for other forest activities are decreased.

**Table 18: Main Resource Used by Scenario 1a and Scenario 3a**

| | Scenario 1a | | Scenario 3a | | Difference |
|---|---|---|---|---|---|
| | March - Oct. | Nov.- Feb. | March- Oct. | Nov.- Feb. | |
| Total arable land used [mu] = | 13.50 | 13.50 | 13.50 | 13.50 | 0.00 |
| +Arable land used for cropping | 9.54 | 9.54 | 9.56 | 9.56 | 0.02 |
| +Arable land rented out | 2.58 | 2.58 | 3.94 | 3.94 | 1.35 |
| +mulberry tree planted in arable land | 1.37 | 1.37 | 0.00 | 0.00 | -1.37 |
| Forest land used [mu] | 6.69 | | 8.82 | | 2.13 |
| Forest land rent out [mu] | 48.00 | | 48.00 | | 0.00 |
| Total labour used [man-day] = | 537.32 | | 537.32 | | 0.00 |
| +Labour used in crop production | 193.44 | | 193.85 | | 0.41 |
| +Labour used in forest activities | 111.50 | | 102.85 | | -8.65 |
| +Labour used in animal husbandry | 7.10 | | 7.10 | | 0.00 |
| +Labour used in silk production | 100.27 | | 108.52 | | 8.24 |
| +Labour used in off-farm activities | 125.00 | | 125.00 | | 0.00 |
| +Hired labour | 37.32 | | 37.32 | | 0.00 |

#### 4.3.2.4. Impact of Reform of Collective Forest Using Right with changing logging quotas

From a natural science perspective, one mu adult forest can harvest 13$m^3$ of wood per year. The amount will not hurt the health of forest. However, Logging quotas is only 0.2$m^3$ of wood can be harvest in the study area for each household. Therefore, more trees are allowed to harvest in the Scenario 4.

Family net income in Scenario 4 increase 13 % (See Table 22) than Scenario 1a. In Scenario 4a, only net income from forestry increase 4289.03 yuan, on the contrary, net income from crop production in Scenario 4a decrease by 439.21 yuan. Animal husbandry and off-farm activities keep the same.

**Table 19: Net Income between Scenario 1a and 4a**

| Income category [yuan] | Scenario 1a | Scenario 4a | Difference (%) |
|---|---|---|---|
| **1) Crop production** | **16597.10** | **16158.89** | **-438.21 (-3%)** |
| + output value of crops sold | 21982.42 | 21396.64 | -585.78 |
| + output value of crops consumed | 0.00 | 0.00 | 0.00 |
| - input value of crop production | 5385.32 | 5237.75 | -147.57 |
| **2) Animal husbandry and silk production** | **3082.65** | **3082.65** | **0.00** |
| + output value of meat and silk sold | 9579.03 | 9579.03 | 0.00 |
| + output value of meat consumed | 1824.00 | 1824.00 | 0.00 |
| - input value of animal husbandry and silk production | 8320.37 | 8320.37 | 0.00 |
| **3) Forest activities** | **1089.00** | **5378.03** | **4289.03 (394%)** |
| + output value of forest products sold | 1229.43 | 5718.34 | 4488.91 |
| + output value of forest products consumed | 150.00 | 150.00 | 0.00 |
| - input value of forest activities | 290.43 | 490.31 | 199.89 |
| **4)Off-farm activities** | **12500.00** | **12500.00** | **0.00** |
| **5)Credit** | **-631.00** | **-631.00** | **0.00** |
| **6)Cost of food bought** | **-2000.00** | **-2000.00** | **0.00** |
| **Total net family income = sum(1-6)** | **30637.75** | **34488.57** | **3850.82 (13%)** |

In Table 23 the most key changing is in timber extract. When more trees are allowed to be cut to develop timber extraction, the land used for timber extraction changed into 1mu. At the same time, area of crop production decrease.

**Table 20: Activities Selected by Scenario 1a and Scenario 4a**

| Activities and resources | Scenario 1a | Scenario 4a | Difference |
|---|---|---|---|
| Crop selected [mu] | | | |
| Grow maize | 9.54 | 9.28 | -0.26 |
| Grow rice | 0.00 | 0.00 | 0.00 |
| Grow tobacco | 0.00 | 0.00 | 0.00 |
| Grow wheat | 0.00 | 0.00 | 0.00 |
| Grow bean | 9.54 | 9.28 | -0.26 |
| Forest activities [mu] | | | |
| Collecting pine tree needles | 6.00 | 6.00 | 0.00 |
| Collecting mushroom | 6.68 | 6.98 | 0.30 |
| Collecting pine tree rosin | 0.00 | 0.00 | 0.00 |
| Timber extract | 0.02 | 1.00 | 0.98 |
| Grow walnut | 0.00 | 0.00 | 0.00 |
| Animal selected | | | |
| Pig fed [head] | 1.00 | 1 | 0.00 |
| Silk production [sheet] | 7.28 | 7.28 | 0.00 |

From Table 24, there are 13.37 mu forest lands are used in Scenario 1a, 46.37 mu should be rented out. In Scenario 4a, more forest lands are used, and less are rented out.

In term of labor using, total labor used increase to 538.3 man-days in Scenario 4a, which is more 0.98 man-days than Scenario 1a. There are more 6.28 man-days labor used in forest activities in Scenario 4a than Scenario 1a, while less 5.3 man-days in crop production.

**Table 21: Main Resource used in Scenario 1a and 4a**

| | Scenario 1a | | Scenario 4a | | Difference |
|---|---|---|---|---|---|
| | Marc - Oct. | Nov.- Feb. | March - Oct. | Nov. - Feb. | |
| Total arable land used [mu] = | 13.50 | 13.50 | 13.50 | 13.50 | 0.00 |
| +Arable land used for cropping | 9.54 | 9.54 | 9.28 | 9.28 | -0.26 |
| +Arable land rented out | 2.58 | 2.58 | 2.84 | 2.84 | 0.26 |
| +mulberry tree planted in arable land | 1.37 | 1.37 | 1.37 | 1.37 | 0.00 |
| Forest land used [mu] | 6.69 | | 7.98 | | 1.29 |
| Forest land rent out [mu] | 48.00 | | 48.00 | | 0.00 |
| Total labor used [man-day] = | 537.32 | | 538.30 | | 0.98 |
| +Labor used in crop production | 193.44 | | 188.14 | | -5.30 |
| +Labor used in forest activities | 111.50 | | 117.78 | | 6.28 |
| +Labor used in animal husbandry | 7.10 | | 7.10 | | 0.00 |
| +Labor used in silk production | 100.27 | | 100.27 | | 0.00 |
| + Labor used in off-farm activities | 125.00 | | 125.00 | | 0.00 |
| +Hired labor | 37.32 | | 38.30 | | 0.98 |

**4.3.2.5: Impact of Reform Collective Forest Using Right with forest certification mortgage credit.**

As we known, there is a second run in each scenario, calling “b” run, including Scenario 1b, Scenario 2b(4mu), Scenario 2b(1mu), Scenario 3b and Scenario 4b. This is a run that give more 5000 yuan credits to farmers for forest production. Table 25

shows difference of net income between “a” run and “b” run in each scenario. It is obviously that net incomes of “b” run in all scenarios are much higher than “a” run. The increasing percentage is at least around 14.08%.

**Table 22: Comparison of Net Incomes of Household in Each Scenario with 0.07 interests**

| | A run | B run | Difference | Percentage |
|---|---|---|---|---|
| Scenario 1 | 30637.75 | 34950.07 | 4312.316 | 14.08% |
| Scenario 2 (4mu) | 30363.48 | 36473.39 | 6109.913 | 20.12% |
| Scenario 2 (3mu) | 30641.02 | 37362.3 | 6721.28 | 21.94% |
| Scenario 2 (2mu) | 30639.93 | 37049.41 | 6409.476 | 20.92% |
| Scenario 3 | 30625.28 | 37166.84 | 6541.565 | 21.36% |
| Scenario 4 | 34488.57 | 41032.97 | 6544.402 | 18.98% |

Table 26 shows that king of production activities in each “b” run are abundant, especially for forest activities. There are four activities can be done in forest, but the model suggest that farmers should not involve in collecting pine tree rosin and walnut trees production in each “a” run. But for “b” run, every forest activities can be done. In each “a” run, the model doesn’t suggest pine trees rosin collection and walnut trees planting, but both of them can be done in each “b” run.

**Table 23: Activities Selected Between a Run and b Run in Each Scenario**

| Activities | Scenario 1 | | Scenario 2 (4mu) | | Scenario 2 (3mu) | | Scenario 2 (2mu) | | Scenario 3 | | Scenario 4 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | a | b | a | b | a | b | a | b | a | b |
| Crop selected [mu] | | | | | | | | | | | | |
| Grow maize | 9.54 | 9.29 | 8.13 | 7.97 | 8.76 | 8.51 | 9.02 | 8.51 | 9.56 | 10.51 | 9.28 | 9.30 |
| Grow rice | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Grow tobacco | 0.00 | 0.00 | 0.00 | 0.16 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 |
| Grow wheat | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Grow bean | 9.54 | 9.29 | 8.13 | 8.13 | 8.76 | 8.51 | 9.02 | 8.66 | 9.56 | 10.51 | 9.28 | 9.30 |
| Forest activities [mu] | | | | | | | | | | | | |
| Collecting pine tree needless | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6 |
| Collecting mushroom | 6.68 | 5.28 | 8.62 | 5.79 | 8.62 | 3.24 | 7.43 | 2.60 | 6.06 | 2.00 | 6.98 | 2.00 |
| Collecting pine tree rosin | 0.00 | 12.00 | 0.77 | 16.00 | 0.00 | 15.00 | 0.00 | 14.00 | 0.00 | 12.00 | 0.00 | 12.00 |
| Timber extraction | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 1.00 | 1.00 |
| Grow walnut trees | 0.00 | 0.05 | 0.00 | 0.56 | 0.00 | 3.91 | 0.00 | 4.37 | 0.00 | 1.36 | 0.00 | 4.55 |
| Grow mulberry trees | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 |
| Animal selected [head] | | | | | | | | | | | | |
| Pig fed [head] | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Silk production [sheet] | 7.28 | 7.28 | 7.28 | 7.28 | 7.28 | 7.28 | 7.28 | 7.28 | 7.28 | 7.28 | 7.28 | 7.28 |

There is a different condition should be mentioned. In Scenario 2a (4 mu), net family income is less than Scenario 1a, so the model suggests that only transfer 3 mu arable lands to forest lands can be accepted. However, in Scenario 2b (4 mu), with 5000 yuan forest credit, transferring 4 mu arable lands still earns money than Scenario 1b. Because of this situation, an extra test was done. Total net incomes are always more than scenario 1a until transferring more than 7 mu arable lands to forest land. (See Table 27) when 7 mu arable lands were transferred to forest lands, the total net family income still goes up by 1%, while the value decreases by 1 % when 8 mu arable lands were transferred.

**Table 24: Comparison of Total Net Family Income among of Difference Area of Arable Lands Transferred to Forest Lands**

| Items | Scenario 1b | Scenario 2b (4 mu) | Scenario 2b (7 mu) | Scenario 2b (8 mu) |
|---|---|---|---|---|
| Total net family income (yuan) | 34950.07 | 37393.81 | 35427.03 | 34729.03 |
| Deference (%) | | 7% | 1% | -1% |

Another phenomenon is worth to mention. In scenario 3a, net family income is almost same with Scenario 1a, even decrease a tiny bit. The model suggests that planting mulberry trees in forest lands is not good for improvement of farmers' income. However, if adding more capital like scenario 3b, comparing with Scenario 1b, planting mulberry trees in forest lands leads a big increasing of total family income. The result indicates that planting mulberry trees in forest land is a good idea. From Table 21, it is seen that more arable land were used to planting other annual crops in Scenario 3b. But, higher input than planting in arable land leads no profit

getting from “a”. If more capital supported forest activities at beginning, farmers do earn money from this idea.

Currently, the bank credit interest is 7%. To test if credit interest went up, whether the forest certification mortgage credit is still worth of carrying? Another plan with 0.15 interest was ran. It is very high interest situation. In spite of this, net family incomes still increase a lot than a run (see Table 28).

**Table 25: Comparison of Net Family Incomes in Each Scenario with 0.15 Interests**

| Total net family income (yuan) | A | B | Difference | Percentage |
|---|---|---|---|---|
| Scenario 1 | 30637.75 | 34863.74 | 4225.99 | 13.79% |
| Scenario 2 (4 mu) | 30363.48 | 36241.49 | 5878.01 | 19.36% |
| Scenario 2 (3 mu) | 30641.02 | 36962.3 | 6321.28 | 20.63% |
| Scenario 3 | 30625.28 | 37166.84 | 6541.56 | 21.36% |
| Scenario 4 | 34488.57 | 35427.03 | 938.46 | 2.72% |