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Impact of reform of collective forest use rights on farmers' production activities and incomes in Heishui village, West Yunnan province, People's Republic of China

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ABSTRACT

Inconsistent and poorly enforced property rights led many not only environmental problems, but economical development restriction as well. A forest tenure reform called "Reform of Collective Forest Use Rights" (RCFUR) has been implemented in rural areas of China to deal with problems of property right. The study aims to assess the impact of RCFUR on farmers' land use and income generating activities at the household level in order to better inform future policy decisions. After surveys and fieldwork in Heishui village at Yunnan province, linear programming models were built to simulate farmers' productive activities. The model results illustrate that household economic well-being can be explicitly enhanced in the study village after implementing RCFUR, but contribution is currently limited. Only giving use right of collective forest is not enough; government still needs to implement other assorted supported policies.

Keywords: Forest tenure, Reform of collective forest use rights (RCFUR), Linear Programming

JEL Classification: A11, B17, C63

1. Introduction

Since 1949[1], policy-makers in China have been exploring suitable forest tenure systems to achieve win-win objectives on environmental conservation and economic development. However, incomplete, inconsistent and poorly enforced property rights led to many, not only environmental problems such as soil degradation and forest depletion, but economical development restrictions as well (Bromley and Cernea, 1989; Feder and Feeny, 1991). In order to deal with these problems, a forest tenure reform called "Reform of Collective Forest Use Rights" (RCFUR) has been implemented in China. There are only two kinds of forest ownership permitted, which are state and collective forest ownerships. 'Collective forest' in China refers legally to "the production and management of forest resources by village/township collective economic organizations or other entities or individuals who are engaged in cultivation, protection and utilization of forest resources on rural collective land" (Miao et al., 2004). Before implementing the RCFUR, collective forest can only be used by all farmers together. Individuals had no right to use it. But after implementing the RCFUR, collective forests were distributed to members of village. Individual farmers get rights to use the piece of collective forest he received for developing production activities. Besides, he also has rights to sell, rent or transfer the use rights to others in the village. In order to deal with the problem of tenure insecurity, using rights of collective forest are guaranteed by law. After forest land measurement and confirmation, farmers can get a paper of certification which confirms that the individual has usufruct rights for certain areas of forest land. The expiration date of using rights of forest is 70 years which is longer than cultivating land use rights.

Does the reform achieve the win-win objective of increased farmers' well-being and forest conservation? How can farmers use forest efficiently? How will it affect the household resource use in the future? This research aims to give answers to these questions by using linear programming (LP) models to simulate farmers' productive activities before and after the reform, meanwhile several scenarios in different conditions were tested. The reform and different conditions' impact are discussed.

2. Literature review

Types of forestry management organization in China have changed many times since 1949 (Song et al, 1997). After the establishment of People's Republic of China in 1949, the first Land Reform Law of 1950 called for the expropriation of land held by the landlords and transferred property to the land-poor and landless (Song et al, 1997). In addition, at the beginning of the mid-1950s, after encouragement of the central government, reforestation of barren lands and wastelands was carried out in most area, especially in the North (Wang, 2004). However, forest management and forestation, like other sectors of society, were damaged by the policy changes of what was to be known as the 'Big Leap Forward' campaign (1959 - 1961) and People's Communes system

[1] After a long civil war, a new regime was established in 1949.

(1958 - 1978). Massive destruction of forests and low efficiency of forestry production happened in this period. The Cultural Revolution (1966 – 1978) is a period when reforestation forest management systems were declining (Zhang, 1989). In the Cultural Revolution, public struggle was seriously disruptive to the normal running of the Ministry of Forestry (Wang, 2004). After Xiaoping Deng who was leader of the Communist Party of China in 1980s took power in late 1978, a great economic reform called the Reform and Open was introduced. In order to match the reform, an agricultural contract system – the Household Tenure system (HT system) – was introduced which gave forestry responsibility to individuals and rural cooperatives by early 1984 (Song, 1997). But, it didn't achieve expected success. Learned lessons, in 2003, the central government launched the Reform of collective forest use rights, which adjust and improve HT system.

Mathematical programming has been used in agricultural economics for more than 30 years. Policy options can be analyzed with models (Hazller and Norton, 1986). Hazller (1986) also wrote that "programming models can be used to analyze the consequences of direct changes in economic structure, such as those that would arise from the introduction of new crop varieties or from land reform that changes the size distribution of farms".

Mudhara et al (2003) used a five-year LP model to compare the profitability of households for new and old technologies: the model evaluates compatibility of new technologies to a level of resources available to the households over time. Decisions on allocation of expenditure to different goods (including farm goods for own consumption and leisure) and allocation of fixed and variable inputs to different production activities in the short run can be incorporated. Single or multiple objectives can be incorporated in the model.

LP was used successfully to test the effects of policies. Frito, Dolisca and Jushua (2008) investigated alternative solutions to the problem of deforestation of Haiti using linear programming (LP) models. They built a LP function to simulate optimal farmer's selection, and then ran several scenarios under different policies to see how incomes of farmers change (Frito, Dolisca, and Jushua, 2008).

3. Methodology: Linear Programming Model

The LP model used in this study is a single periodical model which used to stimulate a household's production activities before and after RCFUR in an average year[2]. The household is set as a middle level household in the village. All coefficients of the model needed are based on the field survey results with 30 samples in 2010/11. The general structure of the basic model is shown in Figure 1. The model consists of the objective function and constraints.

[2] Cost and profit of forestry are distributed in each year by method of Annual Equivalent Value (AEV).

3.2.1 Objective function:

The objective function is to maximize the family income subject to family resource availability and other constraints, for a period of one year. The objective equation is sum of value of crop, livestock, forest products, off-farm income, other incomes and subtraction of production costs and household expenditure. The mathematical form of linear family model is as follows:

$$Max Z = \sum_{j=1}^{n} (P_j X_j - C_j X_j)$$

Subject to $\sum_{j}^{n} a_{ij} X_j \leq b_i$, all i =1 to m and $X_j \geq 0$, all j=1 to n

Where Z = total net income of a household in the study village

X_j = the level of the j^{th} activity. Let n denote the number of possible activities; then j=1 to n

P_j = the price of a unit of the j^{th} output activity

C_j = the cost of a unit of j^{th} input activity

b_i = amount of i^{th} resource available

a_{ij} = technical coefficient (amount of i^{th} input/resource required to produce one unit of j^{th} activity)

m = number of resources and constraints

The components of the objective function are (1) the variable production costs of crop, animal husbandry and forest per unit of land (for crops and forest) or per animal unit, excluding hired labor costs (2) the average sale prices of crops, meat and forest products, which are used to calculate the revenue of farm and forest products (3) rent for arable land which renting out is considered as farm income and renting in is farm expenditure (4) off-farm income and hired labor cost which are determined by the average wage per man-day (5) money spent for buying food or meat, which is also in the objective function even it is not a component of family income in order to provide an alternative source of food supply for household consumption and will be added back to present the final family income and (6) interest for credit (see Figure 1).

3.2.2 Constraints

Constraints on resources are a basic feature of the farming systems (Maurer, 1999). All the information on resource constraints was derived from the micro survey and statistic yearbook in 2010/2011. Several main constraints are explained as follows:

a. Land: The averages of arable land and forest land from 30 samples are assumed to be the maximum land available for cultivation and forest activities.

b. Labor: The average family labour capacity is used as the upper limit of family labour constraints. Household labor can be used for farm and forest production activities as well as off-farm activities whereas hire labour is available when it is required.

c. Crop and meat balance and consumption: Crop and meat products from farm can be sold and consumed in the household. Based on nutrition requirement and living level, crop and meat consumption of an adult per year should be 400kg and 24kg (Yang, 2010). It is used as the minimum annual requirement for household consumption. Maize, rice and wheat is planted to guarantee adequate food supply.

d. Cash balance: The cash inflow is determined by the cash from selling farm and forest products as well as renting land out, off-farm income and from credit received. The cash outflow is determined by the farm expenditure for crop, meat and forest production, hired labor, renting land in, buying food, household expenditure and credit repayment. In the model, cash outflow are not allowed to be more than cash inflow.

3.2.3 Scenarios and Runs

In order to assess different natural and political backgrounds, six scenarios were designed by changing some variables and constraints as explained below. The results of each scenario are compared and the differences are interpreted as the impact of the tested scenarios on resource use and the family income.

Baseline scenario (without RCFUR): This is a fundamental scenario, which simulates farmers' production activities before RCFUR. Before it, farmers' incomes mostly come from planting, off-farm and livestock production. For forestry products, individual farmers only had very limited right to use a little part of the forest (so-called family plots[3]). Farmers' activities in the forest were only collecting forest products (such as mushrooms, fruits and firewood) for household consumption.

Scenario 1 (with RCFUR): After RCFUR, farmers get use rights of collective forest. Productive activities in forest are more and more abundant. Under this scenario, productive activities on the part of agriculture are the same as baseline scenario, but activities in forest are more. Therefore, more variables were added, including planting walnut trees, collecting pine tree resin, timber extraction and collective forest rent out/in.

Scenario 2 (RCFUR+ SLCP): Because of the severe drought of 1997 and massive floods in 1998, the Chinese government decided to implement a project, called Sloping Land Conversion Program (SLCP). In order to control serious soil erosion and plantation damage, the project aims to convert 14.7 million hectares of cropland on steep slopes in the upper reaches of the Yellow and Yangtze River Basins back to forestland and into natural grassland by 2010 (Qu, 2011). Government encourages farmers to plant trees in former arable land. If farmer changed arable land into forest, the government would give subsidy to farmers by area. In Yunnan province, the subsidy is 600 yuan per mu.

[3] Family plot: small piece of forest nearby farmer's house, which only can be used to meet farmers own family consumption, cannot be traded.

			Forestry												
	crop/ livestock product ion	off-farm product ion	collecting pine tree needless in family plots	collecting mushroom in family plots	family plots manage ment	hunted labor	consume crop/meat	consume pine tree needless	crops /meat bought	sale crops/ meat	sale mush room	credit	house expend iture	saving	RHS
objectives (solution vector)	-	+	-	-	-	-	0	0	-	+	+	-	-	+	
constraints															
Arable land available [mu]	1														<=bj
crop/animal production balance	aij						-1			-1					>=0
consumption of crops/ meat [kg]							1		1						>=bj
area for collecting pine tree needless [mu]			1												<=bj
area of family plots management [mu]					1										=bj
pine tree needless consumed [kg]			-aij					1							=0
maximum mushroom can be collecting [kg]				aij											<=bj

			Forestry												
	crop/ livestock product ion	off-farm product ion	collecting pine tree needless in family plots	collecting mushroom in family plots	family plots manage ment	hunted labor	consume crop/meat	consume pine tree needless	crops /meat bought	sale crops/ meat	sale mush room	credit	house expend iture	saving	RHS
mushroom production balance				-aij							1				<=0
labor available[man-day]	aij	aij	aij	aij	aij										
labor limitation of off-farm [man-day]	0	aij													<=bj
credit limitation[yuan]												1			<=bj
minimum of house expenditure[yuan]													1		>=bj
maximum of household expenditure [Yuan]															<=bj
cash[yuan]	-aij	-aij	-aij	-aij	-aij	-aij			-aij	aij	aij	-1	-1	-1	=0

Figure 1. General structure of the baseline farm-household-family linear programming matrix for one year

Scenario 3 (RCFUR + Mulberry tree transfer): Planting mulberry trees and feeding silkworm are a traditional and important production in the study village. Because there was no complete rights to using forest before RCFUR, farmers only planted mulberry trees in arable land. Due to the occupation of mulberry trees, lands for other crops were less. After the RCFUR, a long-term and legal using right guarantee, farmer can plant mulberry trees in forest, and the arable lands can be used to plant other annual crops.

Scenario 4 (RCFUR + Logging quotas changing): To deal with serious deforestation, the Chinese government imposed logging quotas in ecologically sensitive natural forests and restricts harvest levels in severely degraded watersheds. It limited the quantity of timber production each year. Nowadays, most of farmers in the study area complain that the logging quota is too tight. According to this situation, Scenario 4 was set to narrow the logging quotas, enabling more trees to be cut.

Scenario 5 (forest mortgage in S1- S4): Certification mortgage is one kind of new mortgage which is still in discussion without implementation. Most exporters considered it a key to the start of forest production development. Scenario 1b, 2b, 3b and 4b were tested with the adding of a 5000 yuan loan in models to see if it improves farmers' income. Because forest certification mortgage was designed to support forest production, it is only allowed to be used for forestry activities, such as planting walnut tree, timber extraction and collecting pine tree resin.

3.3 Software implementation

Primary data clearing and correction work as well as mean value calculation for parameters used in LP model was done via Microsoft Excel. Data analysis, model input data calculation were implemented in an Excel workbook. Model and different scenarios were built in a Microsoft Excel workbook. The LP models were solved by Microsoft Excel Solver.

4. Data

4.1 Description of the Study Area

The study area is selected on one villages called Heishui (another called Dadian as an alternate) of Heqin County which is located in west of Yunnan. West Yunnan is often referred to as the "Three Rivers Area", because the Salween (Nujiang), Mekong (Lancangjiang), and upper reaches of the Yangtze (Jinshajiang) rivers flow at close distance mountain agro-ecosystems.

Total national area of Heshui village is 12.3 km^2. Area of forest in Heqin county is 16475.2 mu (1 hectare = 15mu)[4], occupied 89.3% of total area. Collective forest covers 88.86% of all forest, which is 14640 mu. The number of households of Heishui village is 305. Main income sources of the village are planting and off-farm activities.

[4] Mu is the name of Chinese traditional unit of area. 15mu = 1 hectare

4.2 Data collection

The primary data include production information, income and consumption data, resource using conditions and family conditions as well as possible future strategies of using forest after getting the collective forest use rights are needed. With permissions and helps of heads of Heishui village, 30 household questionnaires were done in random from total 305 households. Semi-structured interviews for each household and in-depth interviews for key households also were done.

5. Results

5.1 Model Validation

The purpose of validation is to test how realistic the basic model is and how suitable it will be for future strategy testing (Praneetvatakul, 1996). A good model should present results that are close to reality (Regassa, 2002). Hence, the basic models were established as close as possible to reality (actual farmers' practices). However, a gap between the basic model and reality still exists due to the complexity of the real world. If the model could not generate feasible solutions, the matrix and formulas were rechecked and adjusted where necessary.

Table 1 illustrates that the main incomes of household in Baseline is almost the close to result of surveys. Result from surveys is a little bit lower. This may be because baseline scenario is an ideal setting of natural resource, all resources are used ideally, and output of course is higher than practice.

Net income of crop production is lower in Baseline than in surveys. In surveys, farmers mentioned some very occasional income, but it is impossible to show this in the LP model. For example, several farm households planted cabbages in 2010 which they never planted before, and earned money from it. As too much water needed, the crop didn't be extended in the village. However, this still takes account in the income of crop planting.

Net income of livestock production is much higher in Baseline, because when farmers answered the question of income from livestock, they do not take into account the meat they consume by themselves.

For net income of forestry, the number in Baseline model is minus. Because farmers themselves consume most of forest products, they do not count it in a monetary way.

In term of net income of off-farm activities, baseline is lower. This is mainly due to the fact that remittance was excluded in the baseline model. Some family members do off-farm works outside for years. They send some money home. Strictly, this cannot count as off-farm income, but farmers still count it.

For resource used such as arable land, forest and labor, the Baseline Scenario is extraordinarily similar.

TABLE 1. Comparison of Main incomes of farmer household in Baseline Scenario and surveys

Items	Surveys	Baseline	Difference
Main income of household (yuan)=	9619.83	10566.22	946.3912
+Net income of crop production (yuan)	14617.46	13578.25	-1039.21
+Net income of livestock production (yuan)	1131.5	11936.51	10805.01
+Net income of forestry (yuan)	438.87	-184.00	-622.872
+Net income of off-farm activities (yuan)	12877.81	4934.52	-7943.29
+Other income (yuan)	860.42	800.00	-60.42
-Household expenditures	20306.23	20499.06	192.83

In summary, from the results of farm, off-farm and forest income, the baseline scenario is enough approximation to the actual farmers' practices. Consequently, these baseline models are used as a basis for comparison with other scenarios to assess the impact of tested scenarios.

5.2 Model results

This part describes results of the six scenarios running and comparison between scenarios.

5.2.1 Model Results of Comparison between Baseline Scenario and Scenario 1a.

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

The comparison of net income in each income category calculated from solution and price vectors in LP model is showed in Table 2.

TABLE 2. Incomes Comparison between Baseline Scenario and Scenario 1a

Items	Baseline	Scenario 1a	Difference
Income from main productions =	10566.22	14059.77	3493.55
+Net income of crop production (yuan)	13578.25	9995.41	-3582.84
+Net income of livestock production (yuan)	11936.51	11936.51	0.00
+Net income of forestry (yuan)	-184.00	4326.91	4510.91
+Net income of off-farm activities (yuan)	4934.52	7500.00	2565.48

+Other income (yuan)	800.00	800.00	0.00
-Household expenditures	20499.06	20499.06	0.00

From this comparison, total income from main production of Scenario 1a is 14059.77 yuan, which is 3493.55 yuan more than the baseline scenario. After comparing the net income in each category, it is showed that the major differences were from crop production and forestry, whereas for other income categories the results were similar. Income difference from crop production is -3582.84 yuan and 4510.9 yuan for forestry. Income of livestock production is same in both of scenario and off-farm and hired labor change a little bit.

There is a big change in family income structure between Baseline Scenario and Scenario 1a (See Figure 2). In Baseline, income from crop production occupies the greatest part of total income, 46%. After RCFUR (in Scenario 1a), percentage of crop production is reduced to 33%, and livestock production changes to the main income resource. Forestry starts to plays a role in Scenario 1a; its income occupies 12%, much more than in Baseline.

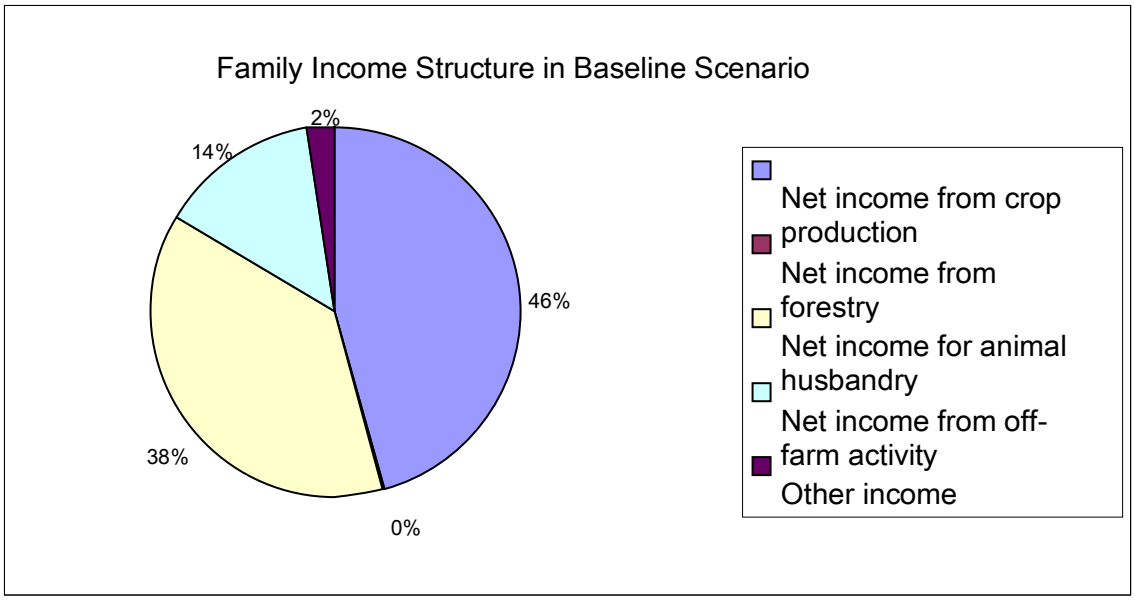

Figure 1. Family income structure both Baseline scenario and Scenario 1a

Table 3 illustrates that before the RCFUR, the arable land was used fully, but only 14.06 mu arable land is used after the RCFUR in total 16 mu of arable land. Because tobacco's high cost and more labor needed, model suggests to grow less tobacco. In order to meet minimum food needed, rice needs to be grown more. For forestry, because there is not enough labor, most of forest lands are still suggested to be rented out. According high cost of money or labor, mushroom collection and planting walnut are not suggested. In terms of labor using, full using has been shown in Baseline already. In Scenario 1a, Labor isn't enough, so there is a need to hire.

12.54man-day labors are hired. Labor for livestock production and forestry are almost same. Labor inputs in crop production were 32.06man-days less than Baseline. Farmers invest a lot of labor in off-farm activities. In Scenario 1a, labor for off-farm activities are fully used.

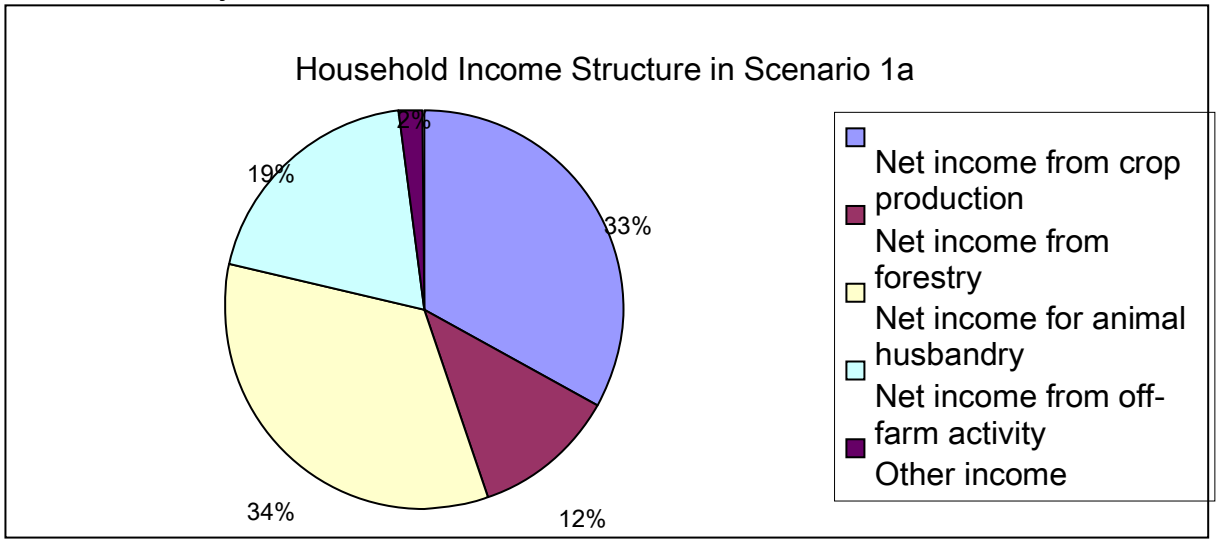

Figure 2. Household income structure both Baseline scenario and Scenario 1a

TABLE 3. Activities Selected by Baseline Scenario and Scenario 1a

Activities and resources	Baseline Scenario	Scenario 1a	Constraints	Difference
Land [mu]				
Arable land used	16.00	14.06	16	-1.94
Forest land used	6.40	51.6	60	45.2
Crop selected [mu]				
Grow maize	1.75	1.75		0.00
Grow rice	2.33	2.86		0.53
Grow tobacco	3.92	1.45		-2.47
Grow wheat	0.02	0.00		-0.02
Grow bean	7.98	8.00		0.02
Forest activities				
Collecting Pine tree needles	6.40	6.02	6-14	-0.38
Collecting mushroom	0.00	0.00	40	0.00
Collecting pine tree resin	0.00	3.58	12	3.58
Timber extract	0.00	0.02	0.02	0.02
Grow walnut	0.00	0.00	6	0.00
Animal selected				
Pig fed [head]	1	1	1	0.00
Silk production [sheet]	14.56	14.56		0.00
Labor used [man-day]	500	512.54	512.54	12.54
Labor used in crop production	133.18	101.13		-32.06
Labor used in forestry	25.20	27.04		1.84
Labor used in livestock production	259.37	259.37		0.00

Activities and resources	Baseline Scenario	Scenario 1a	Constraints	Difference
Labor used in off-farm activities	82.24	125	125	42.76
Labor hired	0	12.54		12.54

To summarize, farmers' household net income increased a little after RCFUR. The potential of forest is explored. Forestry starts to play a role for improving farmers' income, but it is not still the main part of income resource.

5.2.2 Result from Scenario 2: Implementation of 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 3.2.3).

According to the policy, this scenario was run with an increase of available forest land by decreasing available arable land in different percentage, while the total available land per household was not changed.

In the Scenario 2, two plans were done. One is that 4 mu of arable land was transferred to be forest land and another is that only 1 mu was transferred. It is very obvious that net income goes down, when the SLCP is implemented in the study village (See Table 4). Although there is a subsidy (600 yuan per mu), net family income still reduces. Net income in the scenario 2a (4mu) reduced sharply by 21%. Because only 1mu is transferred, scenario 2a (1mu) reduced 2.9% from the Scenario 2a (4mu).

TABLE 4. Household Net Income as the impact of sloping land conservation program

Items	Scenario 1a	Scenario 2a (4mu)	Scenario 2a (1mu)
Net income	12924.74	10256.67	12552.32
Reducing percentage (%)		21%	2.9%

Table 5 shows that even though more areas are added in forest land, it was not fully used. Net income from the scenario 2a (1 mu) is more than the scenario 2a (4 mu), but for availability of forest land, 4mu plan is 91.02% which is higher than 1mu plan. The reason can be that even though the project stimulates forest industry, but forest industry still can not completely replace the role of traditional crop industry, for main farmers' incomes still rely on traditional production.

TABLE 5. Resource used in Scenario 2a (4mu) and 2b (1mu)

Items	Scenario 2a	Constraints of	Scenario2b	Constraints

	(4mu)	Scenario 2a (4mu)	(1mu)	of Scenario 2b (1mu)
Arable land used (mu)	4	4	7	7
Forest land used (mu)	58.25	64	52.34	61
Availability of forest land (%)	91.02%		85.8%	

5.2.3 Result from Scenario 3: impact of planting mulberry tree in forest land

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

There is a big increase in net household income when comparing Scenario 3a to Scenario 1a. The increasing percentage reached 14.09% (See Table 6).

TABLE6. Net Household Income as the impact of planting mulberry tree in forest land

Items	Scenario 1a	Scenario 3a
Net income	12924.74	14746.19
Increasing percentage (%)		14.09%

Table 7 shows that arable land is fully used both in Scenario 1a and Scenario 3a. In terms of forest land, availability of land in Scenario 3a is higher than Scenario 1a. More forest land can be used in Scenario 3a.

TABLE 7: Resources used in Scenario 1a and Scenario 3a

Items	Scenario 1a	Constraints of Scenario 1a	Scenario 3a	Constraints of Scenario 3a
Arable land used (mu)	8	8	13.5	13.5
Forest land used (mu)	51.6	60	56.62	60
Availability of forest land (%)	86%		94.37%	

Planting mulberry trees in forests is a good idea for using land. The reason that it can improve net income should be the following:

Firstly, traditional cropping production still plays an important role in farmers' household incomes. Arable land still is needed. Therefore, planting mulberry trees into forest will release more arable lands for crop production.

Secondly, it is obvious that most of forest land is still spare in Scenario 1a. When mulberry trees are planted in forest, more forests are used. The potential of forest is developed more deeply. Although planting mulberry trees in forest spends higher cost and labor than planting arable land, it is still worth of doing it.

5.2.4 Result from Scenario 4: impact of changing logging quotas

Net household income in Scenario 4 is almost the same as Scenario 1a, although restriction of timber extraction is relaxed. Only 41.99 yuan of income is increased. Because net income from crop production reduced, while net income of forest industry increased, so net household incomes between the two scenarios get balance result. (See Table 8)

TABLE 8. Net household income as the impact of changing logging quotas

Item	Scenario 1a	Scenario 4a	Difference
Net income from crop production	9995.41	9838.82	-156.59
Net income from forestry	4326.91	4537.90	210.99
Net income for livestock production	11936.51	11936.51	0.00
Net income from off-farm activity	7500.00	7500.00	0.00
Net income of household	12924.74	12966.73	41.99

Table 9 illustrates that less arable land used in Scenario 4a, meanwhile more forest land is used. Labor uses are same condition. The change is just a little between the two scenarios.

TABLE 9. Resource used in Scenario 1a and 4a

Activities and resources	Scenario 1a	Scenario 4a	Constraints	Difference
Land [mu]				
Arable land used	14.06	13.94	16	-0.11
Forest land used	51.60	52.34	60	0.75
Arable land rent in	0	0.47		0.47
Forest land rent in	0.00	0.00		0.00
Labor used in crop production	101.13	99.41		-1.72
Labor used in forestry	39.58	41.6		2.03
Hired labor	12.54	12.69		0.16

Table 10 also indicates that although land for timber extraction is fully used, land for other activities goes down. Maybe because of limitation of money and labor, development of timber extraction will restrict other productions' development. In conclusion, after changing logging quota, timber industry improves a little bit. Because incomes from timber industry are always a little, logging quota changes does not impact farmers' income very much. Considering protecting environment and no too much economic benefit, the logging quota has no need to change.

TABLE 10. Forest land use in Scenario 1a and 4a

Forest land use (mu)	Scenario 1a	Scenario 4a	Difference	Constraints
collecting pine tree needles	6.02	6.00	-0.02	14
collecting mushroom	0	0	0	40
collecting pine tree resin	3.58	3.34	-0.24	12
timber extraction	0.02	1.00	0.98	1
walnut planting	0	0	0	6

5.2.5 Result from Scenario 5 ("B" runs): impact of forest certification mortgage

There is a second run in each scenario, called "b" run, including Scenario 1b, Scenario 2b(4mu), Scenario 2b(1mu), Scenario 3b and Scenario 4b, which add forest certification mortgage (for details see 3.2.4) in each scenario.

TABLE 11. Household Net Income in Each Scenario.

	A run	B run	Difference	Change in %
Scenario 1	12924.74	20657.12	7732.38	59.83%
Scenario 2 (4mu)	10256.67	19910.84	9654.17	94.13%
Scenario 2 (1mu)	12522.32	20470.55	7948.23	63.47%
Scenario 3	14746.19	24835.01	10088.82	68.42%
Scenario 4	12966.73	20802.42	7835.69	60.43%

Table 11 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 higher than "A run". This means that forest certification mortgage is significant for improving farmers' income.

The change of net income from Scenario 2a to 2b is worth mentioning. Because arable land is still rare and necessary, Slopping Land Program cannot be implemented well. Net income of Scenario 2a is lower than Scenario 1a. However, net income in Scenario 2b (1mu) is only lower 186.57 yuan than Scenario 1b. If the government subsidy increases to 800 yuan per mu, farmers will earn more profit than Scenario 1b. (The amount of subsidy for PSLP was 600 yuan per mu in 2011) Therefore, forest certification mortgage really supports the implementation of Project of Slopping Land Program which aims to protect natural environments. It can be seen that rare monetary capital is a big restriction on developing forestry. If given enough capital support, farmers' incomes still go up, when arable land is decreased.

6. Discussion.

In term of saving and credit, farmers typically hid the accurate numbers of bank accounts. They do not want to a stranger to know this information. The reason can be

that firstly, rich households are afraid of being robbed and causing jealousy. Relatives of rich households would like to borrow money from them.

The Linear Programming model used in the research is an average year model. For all of long-term productions (output needs more than one year), data was calculated by NVP. However, long-term productions are involved in several periods. A year model still has distance from reality. For future research, multiple-period models can be used. It may be more close to reality.

7. Conclusion and recommendations

After RCFUR, forest can be used more flexibly. More production activities can be done in collective forest. The LP model shows that these activities play an important role in improving farmer household income. Forest potential can be used more efficiently when these productions are carried out. Therefore, the ability of RCFUR's contribution of increasing farm income is obvious but limited currently. Forestry can be used as a supplement activity for farmers' agricultural production but it could not be the main income resource for local farm households in recent years. Traditional crop productions are still a main resource of income. Farmers still rely on crop planting, which cannot be replaced. On the other hand, some other factors still restrict development of forestry, such as low technology, poor capitals and absent labor. Giving only use rights of collective forest is not enough; the government still needs to implement other assorted supported policies, such as subsidy and technological training for forestry activities.

Although Slopping Land Conversion Program (SLCP) was designed to protect natural environment and avoid abusing natural resource, the practice still needs to be considered. Arable lands in the study village are rare. If too many arable lands were transferred into forest, the food security cannot be guaranteed. An increase in subsidy should be considered. Scenario 2a illustrates that if the subsidy of SLCP can add to 800 yuan per mu, farmers' incomes will not be affected when the policy implemented.

Another phenomenon is worth mentioning. All of the scenarios suggest that most of forest should be rented out. It can be explained that small-scale forestry is very costly. It is not still worth of developing. If large-scale forestry is developed, cost can be decrease a lot. For example, cutting trees need employ professional timber jacks to cut, if the area for cutting is too small, the benefit cannot cover the cost of paying of timber jacks. Therefore, it is suggestion that farmers build a group or create a company to collect many single pieces of forests into large scale, and then develop forest products.

It is known that most of forestry activities are long-term productions. At the beginning, there is no profit. Initial capital is very important for developing forestry.

Model shows that adding a loan for forestry, farmers' net incomes have a sharp increase. Therefore, it is necessary to give loans to develop forestry. If farmers only have rights to use forest, but they have no money and technology to develop production, the right is abstract and impractical.

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