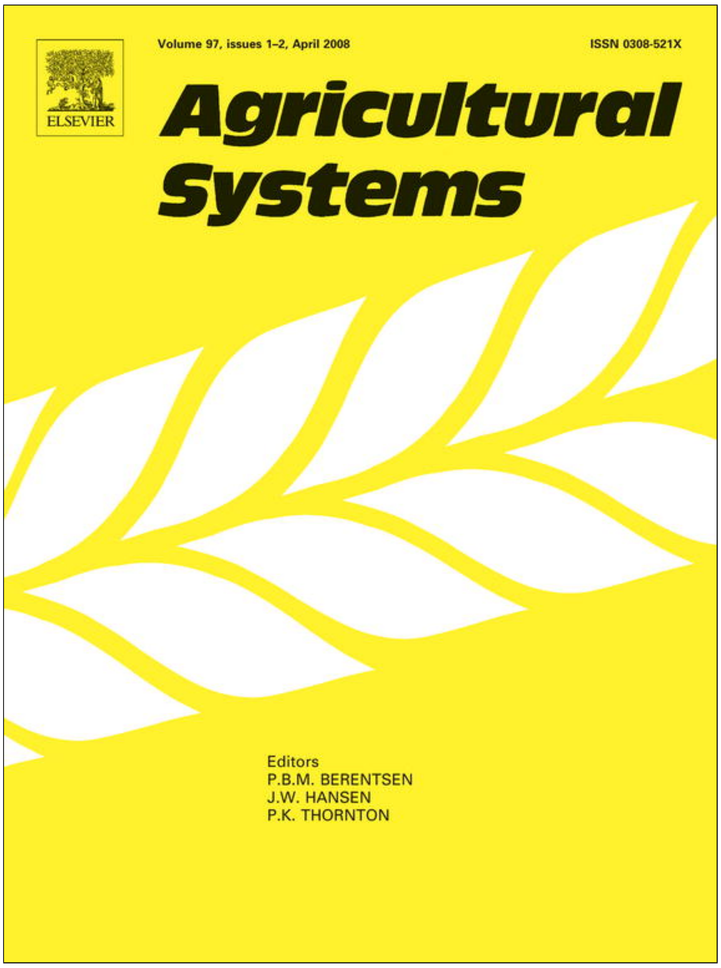
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Economic impacts of shifting sloping farm lands to alternative uses

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Abstract

China has been engaging in one of the world's largest ecological conservation programs, the Slope Land Conversion Program (SLCP), which is also called the grain-for-green policy. This paper is intended to address the economic impacts of shifting from farm lands to four other land use options using land expectation value (LEV). Sensitivity analyses are conducted to examine the impacts by changing interest rates, prices, wage, and tax rates. Current subsidy program is examined as well. The results show that farmers would suffer more losses for planting pine and orchard trees (citrus and chestnut) and tea when interest rates increase. In addition, planting pine trees, orchard trees, and tea create more benefits than annual crops when wage rates increase by 25%. The provision of subsidies by the government could reduce loss from shifting farm lands to alternative uses, but under the current situation (interest rate, price, wage rate and subsidy program), farmers still would prefer orchard trees and tea to pines because orchard trees and tea could generate more land value than pine trees. For the benefit of the program, several policy measures are recommended.

Keywords: Economic impacts; Faustmann model; Land expectation value; Slope land conversion program; Land uses

1. Introduction

Population growth and economic development have resulted in severe environmental problems such as soil erosion, desertification, water shortages and contamination, and loss of biodiversity in China. To support a growing population for food security, more marginal sloping forest lands were converted into farm lands. In the summer of 1998, floods along the Yangtze River devastated large areas of central China killing more than 3600 people. The losses were estimated at 248 billion Yuan (US$30 billion) (Liang, 1998). Sloping land is not only highly vulnerable to soil erosion, but also often is located at the upper reaches of streams and rivers. As a result, farming on sloping land can cause river sedimentation and flooding damages. It is widely believed that cultivation on sloping lands in the upper reaches of the Yangtze River accelerated the damages.

In the wake of the widespread flooding of 1998, the Chinese government launched a huge project – the Slope Land Conversion Program (SLCP) in 1999, in an attempt to shift 15 million hectares of sloping croplands to forests, orchard trees, tea and grasslands in the upper reaches of the Yangtze River and the middle and upper reaches of the Yellow River until 2010. Essentially the central government uses cash and grain to buy the environmental services from the farmers. Therefore, this program is also called grain-for-green policy (see Feng et al., 2005). The estimated budget was 34 billion Yuan (US$4 billion). It covers 25 provinces and autonomous regions and involves more than 1800 counties and 30 million households. By the end of 2003, more than 7 million hectares of sloping cropland had been planted with trees. The total investment was 23.6 billion Yuan, which include grain subsidies of 16.1 billion Yuan, seedling subsidies of 5.6 billion Yuan, and cash compensation of 1.9 billion Yuan (Zhou, 2004).

The SLCP aimed to reduce soil erosion, improve watershed management and ensure the safety of the Three

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Gorges Dam, one of the biggest hydropower generation stations in the world. At the beginning of the program, farmers showed their enthusiasm for participation in the SLCP due to the governmental subsidies. As time has passed by, however, some serious questions have emerged. First, little attention has been paid to the market and price dynamics for these species, given that such a large scale of plantations might cause substantial price drops (CCICED, 2002). Second, implementation costs have been ignored. The operation scale of the SLCP in 2002 was expanded due to the encouraging and enthusiastic responses from farmers and local governments. However, as the project became larger, the delivery of food and cash subsidies to farmers has been delayed and even not materialized, leading to widespread complaints. As a result, the project often became poorly managed at later periods (Xu and Cao, 2002).

A fundamental question is that the program has no objective economic valuation of the alternative uses and the subsidy standard was arbitrarily determined by the central government. Regardless of tree and crop species or local conditions, the subsidy standard for farmers is 2400 Yuan per hectare per year along the Yellow River or 3450 Yuan per hectare along the Yangtze River (Tao et al., 2005). The duration of the subsidies lasts for five years no matter how the market situation changes. Without considering economic motivations through the provision of subsidies by the government, farmers will be hesitant to shift farm lands to forest land. On the other hand, the government needs to determine a reasonable compensation to ensure the sustainability of the SLCP. Some studies have already been conducted on the SLCP (Xu and Cao, 2002; Du and Guo, 2001; Feng et al., 2005), but no in-depth investigation of economic impacts has been conducted. An important aspect is to assess the alternative land use value (Hyde, 1980, 1989; van Kooten and Wang, 1998; Zhang and Li, 2005).

This study is motivated by the need to examine the financial returns of five types of land uses that is needed for policy making. Not only current subsidy program is investigated, sensitivity analyses of interest rates, prices, wage, and tax rates are also conducted to provide additional information when socio-economic circumstances change.

In the rest of this paper, we first describe study area and data collection. Then we briefly introduce the methodology of calculating land expectation value (LEV), which represents the net present value (NPV) of land devoted to a perpetual land management regime beginning with the bare land. That is, the NPV_∞ is equivalent to the LEV. The LEVs from crop land and the four other land uses are estimated and compared. Next, we analyze sensitivity of the LEVs to different interest rates, prices, wages and tax rates. The subsidy program is examined as well, followed by conclusions and suggestions.

2. Study area and data collection

The planning and implementation of the SLCP is a complex process because it targets millions of small households. We briefly describe the main steps in the planning and implementation (for more details, see CCICED, 2002). The program is a typical top-down initiative charged by State Forestry Administration (SFA). The central government assigns the planning task to lower-level governments down to county governments. The county governments are responsible for coordinating implementation. Normally, county forestry departments in cooperation with township governments conduct field surveys and report annual implementation plan to higher-level up to the SFA. After examination and approval by the SFA, the plans are sent back to county-level governments for implementation. First, county governments ask county forestry departments to organize technical teams down to the townships, which further organize farmers in the villages to implement the SLCP. Random inspections are conducted by higher-level authorities up to the SFA. Farmers whose retired croplands pass the inspection and confirmation by the authorities then receive the first portion of grain coupon to the supply station in the county to receive the grain. After plantings have been evaluated, the remaining compensation is delivered to the households.

In this study, Zigui county was chosen because it is representative in the upper reaches of the Yangtze river in the SLCP in terms of ecological and geographic factors, socioeconomic, and significant scale of orchard trees, tea and pine plantations. Zigui county is located at the exit of Xiling Gorge, 30 km upstream from the Three Gorges Dam in the western Hubei province, China. Its longitudinal coordinates range from 101°51′01″ to 111°39′39″ East and latitudinal coordinates range from 30°32′34″ to 31°28′28″ North. The temperatures are mild with an annual average between 15 and 17 °C. Annual precipitation is high, between 997 and 1370 mm and annual the frost-free period ranges from 223 to 273 days. The climate is suitable for orchard, tea, and pine plantations. This county is typical of the western Hubei province.

Since there was no systematic data, we conducted a survey in 40 randomly selected households in this county in 2000–2001. First, four villages were randomly drawn from village list at the Department of Forestry in the county because farmer lists are not available at this level. At the same time, secondary data such as forestry maps, geographical locations of the selected villages were obtained from different levels of governments. Then from each village, 10 households were randomly drawn from the village report. The report also included information on farmer name lists, number of households, population, and annual income per capita, so on. The personal interview approach was used to ensure complete responses and consistency in understanding of the survey questions by the farmers. The questionnaire was carefully designed and contained 50 questions to address input costs, yield benefits, management regimes for five types of land use options, characteristics of farmers and their participation in SLCP program. All households involved in the SLCP program are family farmers. The dominant land use is annual crop production in the past and present in the county. The harvesting regime for crops is twice (summer and fall) a year. Sweet potatoes and peanuts or beans are intercropped with corn and maize. Meanwhile, most of them used less than 30% of their lands for citrus, tea, chestnut, and pine plantations. It must be noted that the household numbers are not large enough for statistical inference, they could represent the county on average. The cost–benefit structure of crop production was collected directly from the households in the county (Table 1).

The cost structure for pine plantation, citrus, tea, and chestnut was obtained directly from the households and the Department of Forestry in Zigui county (Tables 2a and 2b). The establishment activities for pine trees include land preparation, seedling and planting. Management activities include watering, fertilizer, soil scarification, weeding, and pesticide. Pest control and fire control last until the final cut. The thinning cost and final harvesting cost were 35 CNY/m^3. The thinning timber price was 200 CNY/m^3; but final harvesting timber price was 350 CNY/m^3.

There are two thinnings at ages 9 and 13 based on the growth model of pine trees (Wang and Zhuang, 1998). The authors used a single tree model to simulate stand volume growth. We employed a simple exponential volume function to fit the data over time. That is, $\ln Q(t) = a - b/t$, where $a = 3.1481$, $b = -19.8464$. Both intercept and coefficient are significant at the 1% level (respective standard errors are 0.0065 and 0.1084) and adjusted R-square is 0.9998.

In contrast to the pine plantation, orchard trees and tea are more intensive activities. Planting is costly for them. The establishment activities include land preparation, seedling and planting. Management activities involve a variety of watering, fertilizing, weeding, soil scarification, and pest control during the production cycle. Although orchard trees and tea do not require thinning, pruning is critical for Chinese chestnut and citrus cultivation. Citrus begins to be collected six years after planting, and its production increases gradually until it reaches peak at the age of 9 or 10. Then citrus yield becomes relatively stable for about 10 years before gradually decreasing. The production cycle is 30 years. Likewise, some nuts start to be collected at ages 6 and 8 or more for full yield. Production starts to decline after around 25 years and the plantation is replaced after 35 years. Chinese tea starts to be collected earlier at the age of four years. Compared to other orchard trees, labor costs for tea-picking are the highest. Its production cycle is around 32 years. For more information about cultivation and collection, see FML Tea Trading Co. Ltd. (2001). For national cost and benefit structure of major crops, orchard trees and tea, refer to the Agricultural Household Survey Team of China (2001). All prices for crops, citrus, tea, chestnut, and pine timber were obtained from local markets in this county. Prices for citrus, tea, and chestnut are 1, 17, and 7 CNY/kg and the average yields are 19,500, 1073, 2000 kg/ha during reap years, respectively.

Table 2a
Cost structure of pine in the western Hubei, China

Activities	Year	Costs (CNY/ha yr^{-1})	Benefits (CNY/ha yr^{-1})
Land preparation, seedling and planting	1	1530	
Management (incl. fertilizer, weeding, pesticide, etc.)	2–4	300	
Pest and fire control until final cut	5–20	30	
Thinning	9	144	824
Thinning	13	344	1966
Final: harvesting	20	5010	50,095

Author's collection from Zigui county.

3. Methodology

Many methods, such as benefit–cost analysis, net present value (NPV) and internal rate of return, are extensively used to evaluate investment, land use options and agroforestry (Armstrong and Phillips, 1989; Plochmann and Thoroe, 1991; Sullian et al., 1992; Follis, 1993). The land expectation value (LEV) method was intensively applied to examine the allocation of forest land between alternative options (Vincent, 1997; Parks et al., 1998; Barbier and Burgess, 1997; Mendelsohn, 1994; Burgess, 2000; Rodrigo

Table 1
Cost and benefit structure of crops in the western Hubei, China

Type	Seed (CNY/ha)	Fertilizer (CNY/ha)	Pesticides (CNY/ha)	Labor cost (CNY/ha)	Tax (10%)	Yield (kg/ha)	Price (CNY/kg)	Net benefit (CNY/ha)	Ratio of planting area (%)	Net benefit[a] (CNY/ha)
Corn	206.25	457.50	54.45	2468.00	315.00	2715.00	1.16	−351.80	0.8	−281.44[c]
Maize	187.93	793.80	41.40	2400.00	462.00	4125.00	1.12	734.87	0.8	587.90
Sweet potato	567.53	362.70	8.40	3258.00	608.24	30412.00	0.20	1277.53	0.2	255.51
Peanut/bean	529.13	58.35	18.75	1430.00	500.61	1882.00	2.66	2469.28	0.2	493.86
Net income[b]										1055.82

Authors' collection from Zigui county.
[a] Net benefit = yield * price-costs (seed, fertilizer, pesticides, labor cost, and tax).
[b] Net income = the sum of the net benefit times corresponding ratio of planting area.
[c] Corn as a staple food for local farmers, even if its net benefit is negative. One reason is that we use the market wage as the labor cost. In reality, the opportunity cost is much lower in the rural area.

Table 2b
Cost structure of Chinese tea, and Chinese chestnut in the western Hubei, China

Activities	Citrus		Tea		Chestnut	
	Year	Costs (CNY/ha yr^{-1})	Year	Costs (CNY/ha yr^{-1})	Year	Costs (CNY/ha yr^{-1})
Land preparation, seedling and planting	1	13,740	1	12,630	1	10,037
Management (incl. fertilizer, weeding, pesticide, etc.)	2–5	4389	2–3	4239	2–5	1305
Management (incl. fertilizer, weeding, pesticide, pruning, etc.)	6–20	6467	4–22	8479	6–25	5990
Mgt. cost until replaced (10% reduction annually)	21–30	5418	23–32	7608	26–35	3431

Author's collection from Zigui county.

et al., 2001; Guo et al., 2006). One advantage of LEV over NPV is that LEV does not require to annualize present value or transfer the value into an equivalent term at a given period (Rodrigo et al., 2001; Guo et al., 2006). Even though this method is based on the assumption of perpetual land use, it does not mean that the land has to be kept in the same use option forever. The LEV times interest rate, is exactly the annual rental price for the land.

The Faustmann model is a standard economic model to estimate land expectation values in forestry (Faustmann, 1849). It can be applied to other land uses as well. The formula is specified as

$$\mathrm{NPV}_{\infty} = \frac{\sum_{t=0}^{T}(R_t - C_t) * (1+r)^{T-t}}{(1+r)^{T} - 1} - \frac{c-a}{r} \tag{1}$$

where R_t denotes the revenue in the year t; C_t stands for the cost in the year t (including establishment cost C_0); $c - a$ is the annual cost minus annual revenue; T is the rotation age; and r is the interest rate.

The Faustmann rotation is the value of T which maximizes LEV. That is, the optimum rotation age is when the marginal value of holding the current stand is equal to the marginal cost of the land for renting plus the foregone interest payment for timber growth. Considering that there are five types of land uses in this study, we modify the Faustmann model as follows:

$$\mathrm{NPV}_{(\text{timber-tree})\infty} = \frac{\sum_{t=\{9.13\}}(R_{(\text{tree})t} - C_t) * (1+r)^{T-t} + \sum_{t=14}^{T}(R_{(\text{tree})t} - C_t) * (1+r)^{T-t}}{(1+r)^{T} - 1} \tag{2}$$

$$\mathrm{NPV}_{(\text{orchard trees tea})\infty} = \frac{\sum_{t=0}^{T}(R_{(\text{orchard trees tea})t} - C_t) * (1+r)^{T-t}}{(1+r)^{T} - 1} \tag{3}$$

$$\mathrm{NPV}_{(\text{crops})\infty} = \frac{R_{(\text{crops})} - C}{r} \tag{4}$$

In Eq. (2), we have thinning incomes from pine trees at years 9 and 13 and final harvest revenue from the stands at year T as well. In Eq. (3), we have multiple years' income from orchard trees (citrus and Chinese chestnut) and tea. In Eq. (4), we only have annual income from crop production. These three formulae are employed to measure the LEVs for five types of land use options in this study.

4. Results

Based on Eqs. (2) and (3), the optimum rotation ages are calculated by maximizing LEV. For annual crops, we take one year as the rotation age and the LEV is the net present value of one year divided by interest rate ($r = 0.08$) based on Eq. (4).

It is clear that taxation makes difference for all five land use options. With the current tax and interest rates, Chinese chestnut has the highest LEV (40,880 CNY/ha), citrus second (24,213 CNY/ha), Chinese tea third (15,678 CNY/ha), crops next (13,198 CNY/ha), and pine lowest (7632 CNY/ha) (see Table 3). Chestnut, citrus, and tea generate more profits than crops. Pine has lower LEV than crops. Accordingly, the optimal rotation age is 31 for Chinese chestnut plantations, 30 for Chinese tea plantations, 23 for pine, and 27 for citrus. Crops just have one year rotation. Without taxation, the order of the LEVs changes between citrus and tea. Now the LEV of Chinese chestnut is still the highest, Chinese tea is second, citrus third, crops next, and pine trees lowest.

Different land use options have different responses to interest rate change (see Table 3). All five land use options have greater LEVs with an interest rate of 4%, while they have lower LEVs with the interest rate of 12%, compared with the current interest rate (8%). However, orchard trees and tea are more sensitive to interest rate change than crops and pine trees. The possible explanation is that more investment is needed to establish gardens at the beginning of the production cycle. Shifting farmland to pine plantations could generate benefit only if the interest rate is low (4%). The possible explanation is that the pine timber price is low (350 CNY/m^3 on average). Citrus and tea could produce more benefit than crops with either current or low interest rate. However, they generate lower benefit with high interest rate (12%). Compared with crops, only chestnuts have no economic loss for the change no matter how the interest rate and taxes change. In contrast, crops are not so sensitive to interest rate because unlike orchard trees and tea, it does not require more investment at the beginning of the production cycle.

Table 3
Comparison LEV for five types of land use options with tax or without tax at different interest levels

% Interest rate	Land options	With tax		Without tax		Tax reduction only for pine tree by 50%	
		LEV (CNY/ha)	Rotation (year)	LEV (CNY/ha)	Rotation (year)	LEV (CNY/ha)	Rotation (year)
4	Crops	26,396	1	47,480	1	26,396	1
	Pine tree	31,097	29	41,208	28	36,153	28
	Citrus	86,469	25	119,907	25	86,469	25
	Tea	67,134	28	128,080	28	67,134	28
	Chest-nut	107,404	29	136,688	29	107,404	29
8	Crops	13,198	1	23,740	1	13,198	1
	Pine tree	7632	23	10,548	22	9089	22
	Citrus	24,213	27	38,436	27	24,213	27
	Tea	15,678	30	43,597	31	15,678	30
	Chest-nut	40,880	31	53,589	30	40,880	31
12	Crops	8799	1	15,827	1	8799	1
	Pine tree	2133	19	3358	19	2745	19
	Citrus	3871	29	11,783	29	3871	29
	Tea	−1687	30	15,263	32	−1687	30
	Chest-nut	18,741	33	25,950	31	18,741	33

Data from Zigui county, western Hubei province, China.

An interesting finding is that orchard trees and tea are also more sensitive to price changes than crops and pine trees (see Table 4). When the prices of citrus, tea, and chestnut decrease by 30%, the LEVs for all three of them will decrease dramatically. No matter how the interest rate changes, citrus and tea generate lower land value than crops. Even Chinese chestnut has lower LEV than crops when its price decreases by 30% with a high interest rate (12%). If the chestnut price decreases beyond 35%, its LEV is lower than the LEV of crops no matter how the interest rate changes. It is clear that farmers would not return their crop lands to orchard trees and tea if they observe the price dynamics. Likewise, planting pine trees produces lower LEV than crops in either interest rate 8% or 12%, even if its timber price increases by 50%. Only if the price of pine trees increases by 50%, with the interest rate of 4%, pine trees tend to catch up the LEV of crops. It is impossible for farmers to obtain such low interest rates on loans in China. This further explains that there was no large scale shift of farm lands to pine trees prior to the SLCP even if its timber price increases by 50%.

Because crop production is labor-intensive in China (9701 CNY/ha yr^{-1}), it is most sensitive to wage rate increase, with tea second, next citrus, followed by chestnut and pine (see Table 5). When the wage rates increase by 25%, the LEV of all five land use options decreases. Crops become especially unprofitable. Pine and chestnut would not suffer economic loss when wage rate increases by 25%, regardless of the interest rate level. It is clear that the cost in wage in planting pine trees is the lowest among these land use options. The labor cost for chestnut also is low. However, planting citrus and tea would suffer loss with 12% interest rate. Even with 8% interest rate, planting tea would suffer some loss because the cost in wages for picking tea is also high (7207 CNY/ha yr^{-1}), next only to crops.

Table 4
Comparison LEV for five types of land use options with different price decrease of orchard tree and tea at different interest levels

% Interest rate	Land options	Orchard tree and tea price deceased by 30%		Pine tree price increase by 50%	
		LEV (CNY/ha)	Rotation (year)	LEV (CNY/ha)	Rotation (year)
4	Crops	26,396	1	26,396	1
	Pine tree	31,097	29	50,116	28
	Citrus	18,658	25	86,469	25
	Tea	−9776	30	67,134	28
	Chestnut	61,281	29	107,404	29
8	Crops	13,198	1	13,198	1
	Pine tree	7632	23	13,120	22
	Citrus	−4817	28	24,213	27
	Tea	−19,540	32	15,678	30
	Chestnut	20,877	31	40,880	31
12	Crops	8799	1	8799	1
	Pine tree	2133	19	4437	19
	Citrus	−12,394	30	3871	29
	Tea	−22,541	32	−1687	30
	Chestnut	7368	34	18,741	33

Table 6 displays that incentive measures such as tax reduction for pine trees encourage the implementation of the SLCP. If the tax for timber decreases by 50%, which is equal to the current tax on crops, the LEV for pine trees is still lower than the LEV for the crops. Even if timber tax is cancelled for pine trees, it is impossible for pine trees to catch up with the LEV of crops (see Table 3). The result indicates that tax reduction for pine trees alone cannot solve the problem associated with the low return of planting pine trees. When interest rate is 4%, the timber tax decreases by 30% and timber price increases by 30% simultaneously, therefore, pine tree could generate more profits than crops. Alternatively, when tax for pine tree decreases

Table 5
Comparison LEV for five types of land use options with wage rate increase by 25% at different interest levels

% Interest rate	Land options	At current wage level		Wage rate increase 25%	
		LEV (CNY/ha)	Rotation (year)	LEV (CNY/ha)	Rotation (year)
4	Agriculture	26,396	1	−3800	1
	Pine tree	36,153	28	29,062	28
	Citrus	86,469	25	52,737	25
	Tea	67,134	28	28,299	30
	Chestnut	107,404	29	84,593	29
8	Agriculture	13,198	1	−1900	1
	Pine tree	9089	22	6637	23
	Citrus	24,213	27	7195	25
	Tea	15,678	30	−4374	30
	Chestnut	40,880	31	29,775	31
12	Agriculture	8799	1	−1267	1
	Pine tree	2745	19	1434	20
	Citrus	3871	29	−7626	30
	Tea	−1687	30	−15,459	32
	Chestnut	18,741	33	11,469	34

Table 6
Comparison LEV for five types of land use options with tax incentives and price changes for pine tree at different interest levels

% Interest rate	Land options	Tax reduction for pine tree by 50% and pine tree price increase by 30%		Tax reduction for pine tree by 100% and pine tree price increase by 50%	
		LEV (CNY/ha)	Rotation (year)	LEV (CNY/ha)	Rotation (year)
4	Crops	26,396	1	26,396	1
	Pine tree	49,080	28	65,282	28
	Citrus	86,469	25	86,469	25
	Tea	67,134	28	67,134	28
	Chestnut	107,404	29	107,404	29
8	Crops	13,198	1	13,198	1
	Pine tree	12,821	22	17,497	22
	Citrus	24,213	27	24,213	27
	Tea	15,678	30	15,678	30
	Chestnut	40,880	31	40,880	31
12	Crops	8799	1	8799	1
	Pine tree	4312	19	6275	19
	Citrus	3871	29	3871	29
	Tea	−1687	30	−1687	30
	Chestnut	18,741	33	18,741	33

by 100% and pine tree price increases by 50% with the interest rates at either 8% or 4% at the same time, planting pine trees could produce more benefit than crops. Except for the above situation, shifting farm lands to forest lands could cause economic loss for local farmers.

Table 7 demonstrates that the government-initiated subsidy program facilitates shifts in sloping land. When subsidy for citrus, tea, chestnut, and pine is delivered to farmers for five years, all of the four land use options generate higher land values than crops, no matter how much

Table 7
Comparison LEV for five types of land use options with subsidy or without subsidy at different interest levels

% Interest rate	Land options	Without subsidy		With subsidy[a]	
		LEV (CNY/ha)	Rotation (year)	LEV (CNY/ha)	Rotation (year)
4	Crops	26,396	1	26,396	1
	Pine tree	31,097	29	60,142	24
	Citrus	86,469	25	111,508	24
	Tea	67,134	28	89,742	26
	Chestnut	107,404	29	130,478	27
8	Crops	13,198	1	13,198	1
	Pine tree	7632	23	26,549	18
	Citrus	24,213	27	40,161	25
	Tea	15,678	30	30,467	29
	Chestnut	40,880	31	56,256	29
12	Crops	8799	1	8799	1
	Pine tree	2133	19	16,989	18
	Citrus	3871	29	16,856	27
	Tea	−1687	30	10,750	30
	Chestnut	18,741	33	31,554	30

[a] Subsidy for pine trees and cash trees for five years (3450 CNY/ha yr^{-1}).

the interest rate changes. Under these circumstances, farmers who are land value maximizers would be willing to shift their agricultural lands to planting pine, orchard trees and tea. This analysis coincides with the result provided by a household survey (Xu and Cao, 2002). Overall, over 90% of farmers that were actively involved in the SLCP program were satisfied with the program and were willing to shift their farm lands to forest lands. But farmers would still prefer orchard trees and tea to pine trees because orchard trees and tea generate more benefit than pine trees with the same subsidies.

5. Conclusions and implications

This paper has addressed the economic impacts of returning slope farm lands to forest lands by estimating LEVs. One advantage of this approach is its ability to assess the gain or loss of shifting the farm lands to other land uses with changing interest rates, prices, wage rates, and tax rates. The government-initiated subsidy program is examined as well. To sum up, tax reduction could facilitate the land use change because the loss is lower without taxes than with taxes. In addition, planting pine, orchard trees and tea would face higher economic loss with a high interest rate because establishment of cultivation requires high initial monetary investment. Pine trees, citrus, and chestnut would not cause loss, but crops and tea are not profitable at the current interest rate when the wage rate increases by 25%. The possible explanation is that crops and tea are labor-intensive in China. Finally, the provision of subsidies by the government is sufficient to motivate farmers to shift their farm lands to other uses.

Given the current setting (current interest rate, price, tax, wage rate, and subsidy standard), although pine trees could generate more land value than the crops with governmental assistance, the financial returns of orchard trees and tea are still higher than that of pine trees. This explains why farmers prefer to plant orchard trees and tea. In contrast, timber trees can contribute more ecological value in water and soil conservation (Yang and Yuan, 1996). In continuing the program, several policy measures will be recommended to modify some features of this program.

First, the current subsidy mechanism should be adjusted. The subsidies to different options of land use should be different and based on the potential loss to farmers who adopt the changes. If we consider the value of generated environmental benefits, or based on the scheme of cost and benefits of the different land uses, we will be able to determine which land use option is best for society. Thus, a more efficient way is to use savings from the subsidies of orchard trees and tea to increase subsidies for planting timber trees.

Secondly, credit market is very important for farmers. If low interest rate loans are available, the financial returns of orchard trees are higher than that of crops, even without the government subsidies. That means farmers might be willing to convert their farm land to orchard trees and tea without subsidies. It could lessen the amount of subsidies by 40% if the government cancels the subsidies for orchard trees and tea. Given the SLCP's large scale, there is a question of whether these financial sources will remain stable in the long term. Hence, market-based approaches such as developing credit markets and lowering the interest rate for farmers could facilitate the implementation of the SLCP and reduce the implementation costs.

Third, market risk should be considered with the implementation of the SLCP. A market information network on the price dynamics of orchard trees and tea should be established. It happened in Guizhou province where farmers had to cut the chestnut trees and became more interested in pear planting in the mid-1990s because the price of chestnuts declined (Yang, 2001). Market information can substantially reduce risk for farmers.

Fourth, multiple incentive programs should be developed. Whereas the agricultural tax in China is reduced gradually, the timber tax is still high. If the timber tax is reduced to the same level as the tax rate of crops (10%), the LEV of pine plantations could catch up with that of crops, because there is high likelihood for pine timber price to increase by 30%, given the implementation of the national natural forest protection program in 1998.

However, caution should be observed when making applications and deriving implications of these results due to data and technical limitations. Among the implications of the study for future work is the need for larger survey observations. In addition, the ecological benefits of the five types of land use should be considered. Thus, net benefits of the five land uses could be compared completely. Nevertheless, the results using the approach provide important and broad insights into the implementation of the SLCP in China.

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