

# Ecological Afforestation in China: A Market-based Approach<sup>①</sup>

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**Abstract:** This article focuses on the program of Ecological Afforestation on barren lands, degraded arable lands, harvested sites and sloped farmland in Sichuan, China. Farmers were given the opportunity to bid for afforestation activities on their lands. Included in the bids are technical components and specified amount of payment. These bids and predictions of the expected environmental benefits to be generated were used to assess the net benefit of each proposal. Most features of the bidding scheme were successfully implemented and improvements in the economic efficiency of the afforestation scheme were observed. The market-based approach is demonstrated to be a practical way forward for Ecological Afforestation in China. The bidding scheme showed saving of approximately 110,000 Yuan (?? On what scope of the project?) when compared to past programs when compensation was evenly distributed per unit of land. However, the bidding scheme is shown to increase the transaction costs of achieving the policy goal, by about 30 per cent compared to the previous 'command and control' regime. When transaction costs are accounted for there are still cost savings in the market based approach. Finding effective methods to reduce transaction costs will be key to any future implementation of the Ecological Afforestation bidding scheme.

## 1 Introduction

Until recently, China's ecological development projects have been generally implemented by the relevant government departments (such as forestry and water conservation departments), however not enough satisfactory results have been observed from these programs, partly due to the lack of direct participation of farmers. In an attempt to address this issue, the Conversion of Cropland to Forests and Grassland Program (CCFGP) in 1999 sought to engage farmers more directly in the project development to achieve high survival rates at low cost. In practice, the program was still highly regulated, in that farmers seldom had the opportunity to fundamentally influence the planning, implementation, management and evaluation processes (Guo 2005). As such, the project was not successful in maximising the efficient use of program funds. Moreover, the program has been criticised for being ineffective as a large area of sloped farmlands with high ecological benefits were not returned to forests, while farmlands with low ecological benefits had been reforested (Tao et al 2007). Indiscriminate government subsidies were provided to farmers across the country without

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valuing variations in predicted ecological benefits, which led to low project cost-effectiveness. In addition, some farmers also experienced a net loss as a result of program participation (Xu Jintao, 2004).

It is important to also recognise that program inefficiencies are not unique to this project, as other ecological conservation projects in China (e.g. the Natural Forest Protection Program and Ecological Benefit Compensation Program) have also encountered similar problems. Given the inevitable injection of environmental conservation funds in China over the next few years, it is critical that funding for future ecological projects are efficiently allocated to ensure environmental net benefits are maximised.

These issues have highlighted that Pigovian taxes and subsidies are not fully effective due to severe information asymmetries. Adjustments to the program implementation approach are therefore essential. However, it is not clear whether a market-based approach is capable of addressing these issues. The objective of this study is to determine whether a market-based approach, specifically the bidding scheme introduced in the Land Use Change Program (LUC bidding scheme) will improve the efficient use of government funding for ecological restoration in China.

Over the last twenty years, various market-based approaches had been applied to the programs of environmental conservation and natural resource management in China. In particular, the method of auctioning has been widely used to transfer government-owned land and natural resources to the highest bidder. The transaction efficiency for government as a monopoly seller suggests that a market-based approach can be an effective alternative of improving efficient land use practices. Correspondingly, bidding as an implementation approach is believed to increase transaction efficiency for government as a monopoly supplier. It is important to recognise, however, that a bidding scheme approach has not yet been conducted in China for environmental or natural resource management purposes. This study aims to analyse and evaluate the effectiveness and feasibility of allocating funds for ecological conservation through a bidding scheme by conducting field experiments in Pengzhou and Hongya Counties in Sichuan province.

This paper is structured as follows. In the next section, Part 2 introduces the project background. The project specifications are described in Part 3. Part 4 evaluates the project effects. Finally, Part 5 provides some discussion and conclusions

## **2 About the Project**

### **2.1 Content and goals of the project**

Yangtze River, the largest river in China with a total length of 6,300 km, spans across southwest, central, and east China and connects 19 provinces (with municipalities and autonomous regions included) with an area of 1.8 million km<sup>2</sup>, (about 20 per cent of China's land area). Over many years, the mountainous areas surrounding the Yangtze River basin have faced serious cumulative ecological and environmental degradation and soil erosion

problems. According to the second national remote sensing survey on soil erosion,, the total area of soil erosion along the Yangtze River amounts to 637,400 km<sup>2</sup>, about 80 per cent of which occurs in the upper and middle reaches of the basin.

Sichuan Province is located in the upper reaches of the Yangtze River in southwest China, with a total area of 485,000 km<sup>2</sup> and a total population of 88,600,000 (as of 2009). The terrain of Sichuan Province is high in the west and lower in the east with plateaus and mountains with an altitude of 4,000 meters in the west, and basins and hills with an altitude ranging from 1000 to 3000 meters in the east. This landscape has meant all rivers in the Province flow into the Yangtze River, also bringing a lot of sediment into the river. The latest remote sensing survey data indicates that Sichuan Province is the most seriously affected by soil erosion in the upper Yangtze River region, and potentially in China (cite). The survey data also indicates the total area of soil erosion is 160,000 km<sup>2</sup>, accounting for one third of the total land area and 56 per cent of the eroded area in the upper Yangtze River. Environmental improvements in Sichuan Province are of considerable importance to future agricultural production and economic development in the Yangtze River basin.



Figure 1: The Position of Sichuan Province and the Yangtze River in China

In order to accelerate the ecological restoration in the Upper reaches of the Yangtze River and to improve the ecological quality of the Yangtze River, a three-year ecological afforestation program on barren lands, degraded arable lands and harvested sites has been implemented in Sichuan Province from 2009 to 2012 with the purpose of creating 1,000 acres of ecological forest. The goals of ecological afforestation are to:

- 1) improve water quality;
- 2) control soil erosion to reduce the amount of sediment flowing into the Yangtze River;  
and
- 3) increase the number of fauna and flora species and improve biodiversity.

The project also examines whether a market-based approach will help improve the efficiency of the use of government ecological funds. The project does this by analysing the feasibility of allocating funds for ecological construction through a bidding scheme where individuals place a bid for the amount they are willing to accept to convert their land into an ecological

forest. In doing so, this process aims to maximise both the ecological benefits of ecological afforestation and the efficiency of ecological funds.

## 2.2 Project Location

The villages selected for the project are located in Hongya County and Pengzhou County of Sichuan Province. Hongya County is located in the southwest of the Sichuan Basin, 147km from Chengdu (the capital city of Sichuan Province), with a total population of 330,800 and an area of 1896.49km<sup>2</sup>. The county is characterized by mountains and hills and known as "seven mountains, two rivers and one field" with its altitude ranging from 417.5 meters to 3090 meters. Hongya County is one of the most important forest counties in Sichuan Province with 0.132 million ha of forestry land.

Pengzhou County is located to the northwest of Chengdu by 25km, with a total population of 780,000 and an area of 1420km<sup>2</sup>. The terrain of Pengzhou County is mountainous and is high in the northwest and lower in the southeast. The mountains, hills and plains account for 50%, 11% and 39% of the total area respectively. In contrast, the area of forest land in Pengzhou County is less than that of forest land in Hongya County, i.e. 0.067 million ha of forestry land.



Figure 2: The location of Pengzhou City and Hongya County in Sichuan Province

Overall, Pengzhou County and Hongya County are economically underdeveloped regions. The per capita GDP in both counties is far below the national average level, and also lower than the average level of Sichuan Province. The agricultural output value and the proportion of employment in agriculture are higher than national and provincial levels. Farmers in both counties are comparatively wealthy and the per-capita net income of farmers in 2008 is equal to or higher than the national average, and well above the average level of Sichuan Province. In addition, the per capita arable land in Pengzhou County and Hongya County is below the national average. The per capita forest area in Pengzhou County is less than that in Hongya County, and only amounts to one eighth of the per capita forest area of Hongya County.

Table1: Comparison of natural and economic indicators (2008)

	Pengzhou	Hongya	Sichuan	China
GDP per capita (Yuan)	12617.56	11537.14	15367.72	22640.47
Net income of farmers per capita (Yuan)	5228.00	4720.00	4121.21	4761.00

Proportion of agricultural output (%)	26.90	25.30	18.92	11.31
Proportion of rural population (%)	83.79	88.57	62.60	54.32
Proportion of employment in agriculture (%)	30.57	33.14	26.94	23.08
Arable land per capita (Mu)	0.64	0.56	1.10	1.37
Per capita food production (Kg)	317.31	387.43	385.84	397.96
Forest land area per capita (Mu)	1.26	5.67	4.18	3.22
Forest area per capita (Mu)	0.54	4.81	2.70	1.98
Forest cover (%)	40.30	65.80	30.80	20.36

1mu=0.667ha

### 2.3 Project Cycle

The project cycle of ecological afforestation is 3 years commencing in June 2009 to June 2012. Accordingly, the planting cycle and management program are also 3 years. The farmers' bidding stage was completed in June and July 2009.

### 2.4 Project Operation Mode

The individual contractors for ecological construction were selected through a bidding process. The government (agency) provided a detailed overview introduction about the project in the selected areas and invited land contractors to submit bids. Farmers are expected to make their own afforestation and management plans in accordance with the technical requirements and then the agency select the successful farmers based on the evaluation of ecological benefits and bid price. Successful farmers are expected to implement the project in accordance with their afforestation and management plans and the agency is to provide payments as stipulated in the contract.

A single round sealed bid was adopted during the bidding, i.e. each farmer had only one chance to present their bidding price simultaneously without knowing the prices of other tenders. The underlying logic of the process involves competition among farmers – those who submit the most competitive bids have the highest probability of winning the project. The lowest bids that provide the best ecological benefits criteria are financed until all the funding is expended (or the goal of the project has been achieved). Higher bids are not accepted because they do not represent high levels of cost effectiveness. The successful bidder then signs a contract with the agency in accordance with the actual bidding price and payments are made.

### 2.5 Scope and characteristics of tenders

Based on extensive consultation with the project team and residents of Pengzhou County and Hongya County, two villages (Wenshan and Shunhe) in Hongya County and two villages (Dishui and Zhongba) in Penzhou County were selected as the project sites. All the farmers in the four villages are eligible to bid for the ecological afforestation project.

According to previous research, it is known that education levels amongst potential tenderes can significantly influence project implementation. For example, reasonable levels of education can improve the level of project understanding amongst a village community. As can be seen from Table 2, 80 per cent of the population in the four selected villages hold an education of no less than junior high school. It was believed that this level of education would help ensure that project participants understood the project objectives and operation. In addition, the off-farm employment rate is below 25 per cent, implying that there is a sufficient supply of labor to ensure project implementation.

Table 2: Social characteristics of the selected villages (2008)

		Hongya		Pengzhou	
		Wenshan	Shunhe	Dishui	Zhongba
Households		565	640	214	305
Population		1905	2195	842	1035
The amount of labor		1040	1560	460	662
Level of education	Primary and below (%)	20	30	13	30
	Junior school (%)	60	60	74	60
	High school and above (%)	20	10	13	10
Off-farm employment	Population	240	329	40	23
	Percentage	25.1	15	8.7	2.2
Per capita income (Yuan/Year)		6155	5658	3400	3860
Arable land (per capita)		0.03	0.23	0.82	0.1
Forest area (per capita)		16.12	2.1	9.14	6

### 3. Project Implementation Process

In order to achieve the experiment goals, we developed a project implementation plan with ten stages (refer to Table 3 below). Table 3 provides some detailed information about the project implementation plan and information obtained from site visits to the four villages in July 2010<sup>②</sup>.

Table 3: Ecotender process

Process		Department	Famers
1	Expressions of Interest	Publicize the bidding trial project	Register expressions of interest
2	Training	Provide training to technical staff who will help farmers prepare the bids	N.A.
3	Site Survey	Conduct biophysical survey of lands included in the	N.A.

<sup>②</sup> To assess the effect of the project, the project team conducted a post-bidding socio-economic survey in July 2010 to gather information about the rural households in the four selected villages. A total of 196 households were covered in the survey, of which 152 households are tenders and 44 households didn't participate in the bidding process.

		Expression of Interests letter	
4	Drafting and Developing Afforestation and Management Plans	Provide technical guidance to participating farmers	Draft an afforestation and management plan
5	Submission of Bids	Organise the bidding trial	Submit bidding documents
6	Building biophysical models	Predict household level changes	
7	Valuation of the environmental benefits	Conduct CM survey and estimate environmental values of the bids	
8	Bid Assessment	Rank bids and select successful bids	
9	Letter of Acceptance	Deliver letter of acceptance	
10	Signing of Contracts, Monitoring and Fund Allocation	Sign contracts with successful bidders, organise the monitoring of compliance and allocate funds	Sign contracts and plant trees

### 3.1 Expression of interest to participate

An expression of interest to participate in the project is a key element to the project. Based on information provided by farmers about their willingness to participate in the project, the supply scale for ecological restoration can be well understood, which also provides information for the design of the bidding scheme.

The expressions of interest to participate involved two stages: project publicity and registration. The objective of project publicity was to provide a detailed introduction on the project by organizing a village meeting for potential participants of the bidding scheme who were also land contractors, and to provide information on the project including project objectives, content, methods of operation and specific procedures. The key goal during this phase was to ensure project information was accurately conveyed to all interested village members to eliminate the risk of non-participation due to a lack of access to complete information.

Table 4: Methods used to access project information

	Village announcement		Heard from others		Do not know	
	Pop	Per	Pop	Per	Pop	Per
<b>Participants</b>	149	78.84%	3	100%	0	0%
<b>Non-participants</b>	40	21.16%	0	0%	4	100%
<b>Total</b>	189	100%	3	100%	4	100%

As a whole, the studied villages had high percentages of participations, and only a very small number of households that did not obtain the project publicity information (as shown in Table

4 above). Project information publicity included media coverage via television, radio, newspapers and a village meeting. From the perspective of practical implementation, the village meeting was the most effective and common form of publicity in the studied villages, while other publicity methods proved to be less effective in drawing farmers' attention. The quality of publicity for the project can be evaluated by assessing the level of farmers' understanding. We use the CCFGP as a comparison. For example, when farmers were asked "Do you think there is any difference between reforestation projects conducted through bidding and the CCFGP", 76 per cent of farmers involved in the bidding answered "yes". In addition, 58 per cent of farmers who answered "yes" can further state the specific differences between them.

Information was requested to confirm that farmers who were interested in the bidding trial were land contractors, and that the period of their leases covered the whole project cycle from 2009 to 2012. This ensured that the farmer participants held the necessary property rights to undertake the restoration and were able to make decisions on the use of their lands. The interested farmers were then requested to register their willingness to participate in the bidding trial.

A well-designed expression of interest to participate can identify problems in an early stage and allow for promptly corrections to them prior to the project commencement. We were encountered with some problems and made timely adjustments in the investigation of willingness to participate. Dishui Village in Pengzhou was not originally selected for the project. Rather, Hongyan Village was originally identified as a possible project site. However, during the survey we found "bidding" a very difficult process to be conducted in this location. When we arrived at Hongyan village to undertake a site assessment, we met 80 village community members. However, only 15 were males (the majority of whom over 60 years of age), and the rest were female (most of whom also over 60 years old). We observed that the majority of the active labour force were engaged in off-farm employment out of Pengzhou.

In addition, when community members were asked to register their willingness to participate in the project the response rate was very low. We discovered that the community had a very poor understanding of the project. Following our encouragement, someone asked: "What is registration? What are we going to do?" We also assessed the understanding of the project communicators in the Department of Forestry to ensure the information being conveyed was accurate. We observed that their understanding was accurate and clearly articulated. However, although the communicators had been actively publicising the project prior to our arrival as previously agreed, it became apparent that the predominantly elderly village community were largely uneducated or under-educated, and subsequently, they were struggling to comprehend the project design and objectives. Upon further investigation we discovered that the average level of education for females over 60 years of age in this community was between 2 and 3 years. Illiteracy was also identified as an impairment to successful project implementation.

We also took into consideration the social and cultural dimensions. The role of women (especially elder women) in family decision-making in this village is limited. Their lack of



experience in the area also reduced their ability to understand the content of the project. The project requires project participants to undertake a cost-benefit assessment and preferably have a simple understanding of their opportunity cost. Elderly women were not regularly involved in these decisions so it was unlikely that they were able to provide an accurate bid.

We conducted a second assessment in the Hongyan Village and arrived at a similar conclusion. We found that it was not feasible to implement the bidding trial in this village. People with low levels of education found it difficult to complete the tender application and would often resort to copying somebody else's bid. Combined with a lack of general experience in production decisions, this meant many were not familiar with the concepts. For these reasons, we decided to abandon the experiment in Hongyan Village and select the alternative fourth site.

We believe that the failure in Hongyan Village can be avoided and the key issue is the time to carry out the bidding. Arranging the project before the Spring Festival, or before and after the busy farm season. With the target labour force present, this could improve the success rate of the project. When we talked with the villagers in the Hongyan Village, they generally agreed that their family members (particularly husbands and sons working out of the village) were likely to understand the project in greater detail.

### **3.2 Tender training**

Before the bidding trial was conducted, we provided training for the technical services staff and farmers participating in the project. This included specific training on planting and management skills, such as information on suitable tree species, given a variety of terrain, soil, hydrology and other natural conditions, and forestry and management procedures.

Targeted training to the technical services staff was also provided to ensure they were appropriately equipped to assist farmers in planting and management programs to maximise ecological benefits and cost effectiveness. One of the challenges identified in this process related to managing relationships between technical staff and farmers. It was challenging at times when technicians and farmers distinguished between their inter-related but different roles. Occasionally, technicians have tended to overpower farmers' decisions on the basis that they are more knowledgeable. Making technicians recognise that farmers are capable of making sound decisions based on their knowledge of their country has been a slow process. Reiterating that the role of the technicians is to provide sufficient assistance to facilitate the decision making process of farmers, without providing information on the tender price, has been a critical step. Overall, however, the technical training was positively received and the staffs have helped to achieve good results, particularly in relation to providing farmers with assistance in developing planting and management plans.

The farmers mainly received training on sustainable reforestation, forestry management programs and tender processes to ensure that they could work out a reasonable program of reforestation and management, and were able to complete the tender independently. This was

achieved through intensive training sessions in forms of open village meetings and specialised meetings for technical staff and farmers. Given the volume of participants in some of the meetings, it has been necessary to conduct multiple training sessions to ensure the messages were clearly conveyed and understood by all participants.

The training of farmers was completed by the village committee. Firstly, the village cadres were trained to ensure that they could train the farmers to master the bidding process. The training of the farmers was done in a village meeting and in small groups. The effect of training in small groups was found to be better than the training in village meetings, and should be adopted in future application.

### **3.3 Site survey**

The technicians were responsible for collecting biophysical data on the project sites, including land area, land titles, topography, soil, hydrological, biological and other factors. These data provide the technical basis for the design of afforestation and management activities under the bidding scheme. Since farmers are mainly in four administrative villages and the natural conditions in these four case study villages are similar, we have not conducted site investigations on each planting site. Rather, line survey and typical survey methods are used. During the site survey, we requested all of the technical staff to participate so they could have a good understanding of the variety of land types and provide valuable advice in helping farmers develop reforestation and management plans.

In addition to the field survey conducted by technicians, farmers were also required to provide detailed information on their own land, including land area, elevation, slope, soil type, soil depth, access to water and other natural features and indicators. These indicators together with farmers' planting and management plans were then input to the biophysical model, which was used to evaluate the ecological benefits of each plot.

### **3.4 Developing afforestation and management plan**

With the help of technicians, farmers developed afforestation and management plans according to the characteristics of their own land. Under the technical standards for afforestation proposed by Sichuan Department of Forestry and the local forestry bureaus, we produced a formatted forestation and management form that set out details of the afforestation and annual management plans adopted, and provides farmers with options to choose particular management practices. This process allows farmers to make informed decisions about reforestation programs on their land. Importantly, this allows farmers to exercise their right to make autonomous decisions about tree species, density and forest land area. The post-bidding survey results indicated that afforestation and management rights of farmers have been largely respected in the process with more than 95 per cent of farmers indicating that they have discretion in tree species, forest area and forest land area (see Figure 3).

Further data suggests farmers did not encounter particular difficulties in the process of developing afforestation and management plans. Many of the farmers have an enriched understanding of afforestation and forest management. Another important benefit of the project relates to the increase in ecological awareness generated by the project as the project provides farmers with a solid foundation on the value of ecological benefits.

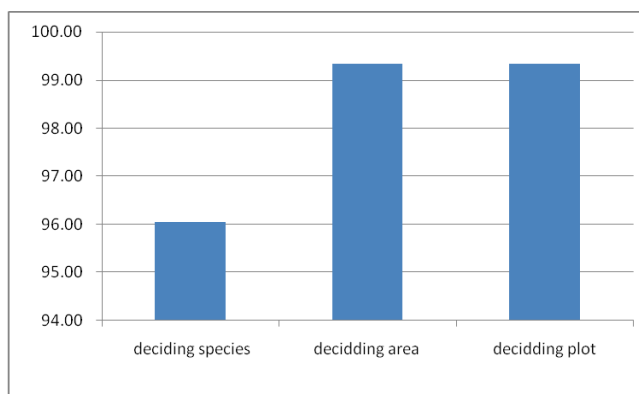


Figure 3: The afforestation and management rights of farmers

### 3.5 Tender

The tender process is the core element of this project. Once afforestation and management plans were developed by individual farmers, they then made their own tender offer (or bid). Throughout the process, we have emphasised that farmers must submit bids independently of each other, and bids can not be influenced by any other person or institution.

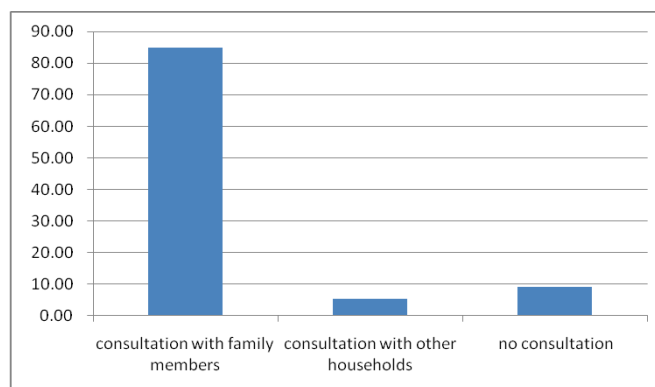


Figure 4: The consultations before completing the tender

While about 40 per cent of households received external assistance to complete their bids, we did not encounter any instances where farmers colluded or copied by bids. Assistance was primarily sought in relation to estimating the costs for seed, fertilizer and pesticide. There was no leakage of bidding price information to other bidders. Interestingly, before completing the tender, over 90 per cent of heads of household discussed their submission with others. About 84.87 per cent of heads of household discussed their bids with their family. No more than 5

per cent of farm households discussed the bids with neighbourhoods. From these information we concluded that a high level of independency was maintained during the tender preparation process.

Given the limited experience and exposure of farmers to such a market approach, a relevant question is whether farmers' bids are rational. It was found that the bids received were generally lower than government subsidies. Of these, only 2.06 per cent of farmers did not seriously consider their own costs, but simply followed others. Around 20.06 per cent of farmers worried that high bid price might lower the chance to win the bids. However, about 75 per cent of households seriously considered their opportunity costs when formulating their bids. As seen from the figure below, the bid prices of most farmers are rational.

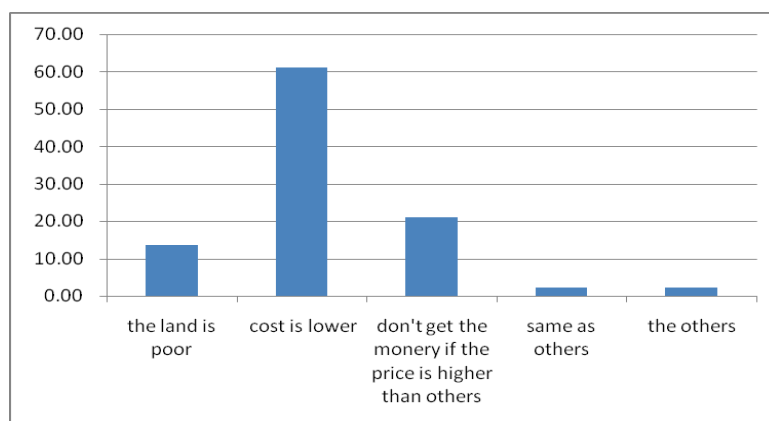


Figure 5: The reason of farmers' bids received were lower than government subsidies

In the bidding design, we provide the possibility of bundling multiple land plots into one single bid or including each land plot in separate bid. This gives flexibility to participating farmers if they wish to involve more land plots in the bidding trial, and depends entirely on the type of land plot and the farmers' willingness. In the bidding process, farmers generally submitted separate bids for different plots of their own based on the cost difference. This is because plots of land are often dispersed and belong to different site types, implying different unit price for different plots. If all the land plots were bundled into a single bid, this may increase the total bidding price. The bidding trial has shown that farmers prefer to submit individual bids for each land plot, implying a non-flattened supply curve was used about farmers with multiple plots and various levels of opportunity costs.

We also provide the possibility of joint bidding in the project design, allowing two or more farmers to bid together if they wish to do so. However, we requested joint bidders to have adequate consultation in advance and select a person as a representative to sign on the bidding document. In the bidding process, we did find a lot of joint bids. Joint bidding required applicants to address two conditions: 1) the plot connection among the bidders; 2) farmers were lack of certain elements for afforestation and management activities (mainly labor), the complementarity requirement among the elements promoted farmers to cooperation.

Table 5: The bidding trial results

	<b>Wenshan</b>	<b>Shunhe</b>	<b>Dishui</b>	<b>Zhongba</b>
Number of bidder	79	66	90	68
Number of nominated sites	80	67	93	124
Bid area (Mu)	985	330.7	3226.5	663.2
Minimum area (mu)	1	0.5	0.5	1
Maximum area (mu)	35	30	280	50
Total bid price (10,000 yuan)	15	2.8	72.76	14.97
Average bid price (yuan/mu)	152.4	84.5	228.6	225.7
Minimum bid price (yuan/mu)	47	49	24	20
Maximum bid price (yuan/mu)	952	210	324	1500

1mu=0.667ha

### **3.6 Valuation of environmental benefits and bid evaluation**

Bid evaluation involves a cost benefit analysis of each bid submitted. The potential environmental benefits of each bid were derived by combining the biophysical model and the choice modelling results. While the biophysical model focused on the environmental changes at the farmer household level, the choice modelling research produced an estimate of the monetary value of these environmental changes through the willingness to pay of population in the middle and lower reaches of the Yangtze River. The value of the environmental benefits for each bid was then compared to the bid price and the net benefit of each bid was calculated. Finally, the bids were ranked based on their net benefits from the highest to the lowest until government funding was exhausted. Results show that all bids in Wenshan and Zhongba Village in Hongya and Shunhe Village in Pengzhou were successful, while about 851.3 mu of land were funded in Dishui Village in Pengzhou.

### **3.7 Signing of Contracts, Monitoring and Fund Allocation**

After determining a winning bid, the local forest bureaus and successful farmers enter into a written contract. The compliance of contracts is being monitored by local forest bureaus and funds are allocated in accordance with the contract. The task is facilitated by the Sichuan Department of Forestry, with contracts signed and monitoring conducted. Initial payment has also been made to successful bidders.

## **4 Evaluation of Project Effects**

Evaluation of the project includes an assessment of the cost effectiveness of the bidding scheme. Shown below are marginal cost curves of the bidding scheme in each of the four villages, where the horizontal and vertical axes represent the cumulative environmental benefit and the tender price respectively. As can be seen, the bidding scheme shows marginal cost bid increase, that is, with the gradual expansion of forestation area through bidding, the subsidies of remaining land into forestation projects will be higher and higher, which is in line with the economic theory.

Afforestation under the bidding scheme is found to improve the cost effectiveness of government funding when compared to forestation on barren lands under the CCFGP. As Table 6 shows, the total forestation area of four villages is 2825.24 mu, which would require a subsidy of 565,000 Yuan under the CCFGP. However, through the bidding scheme payments are 455,000 Yuan in total, implying a saving of 110,000 Yuan. The negative cost saving effect of Zhongba Village is caused by the increase in government funding in order to include all proposed bids into the bidding trail by the county level of government under the consideration that the total bidding area is not large enough. However, it also reflects another advantage of tender forestation, as farmers will not be damaged due to participating in ecological forestation activities.

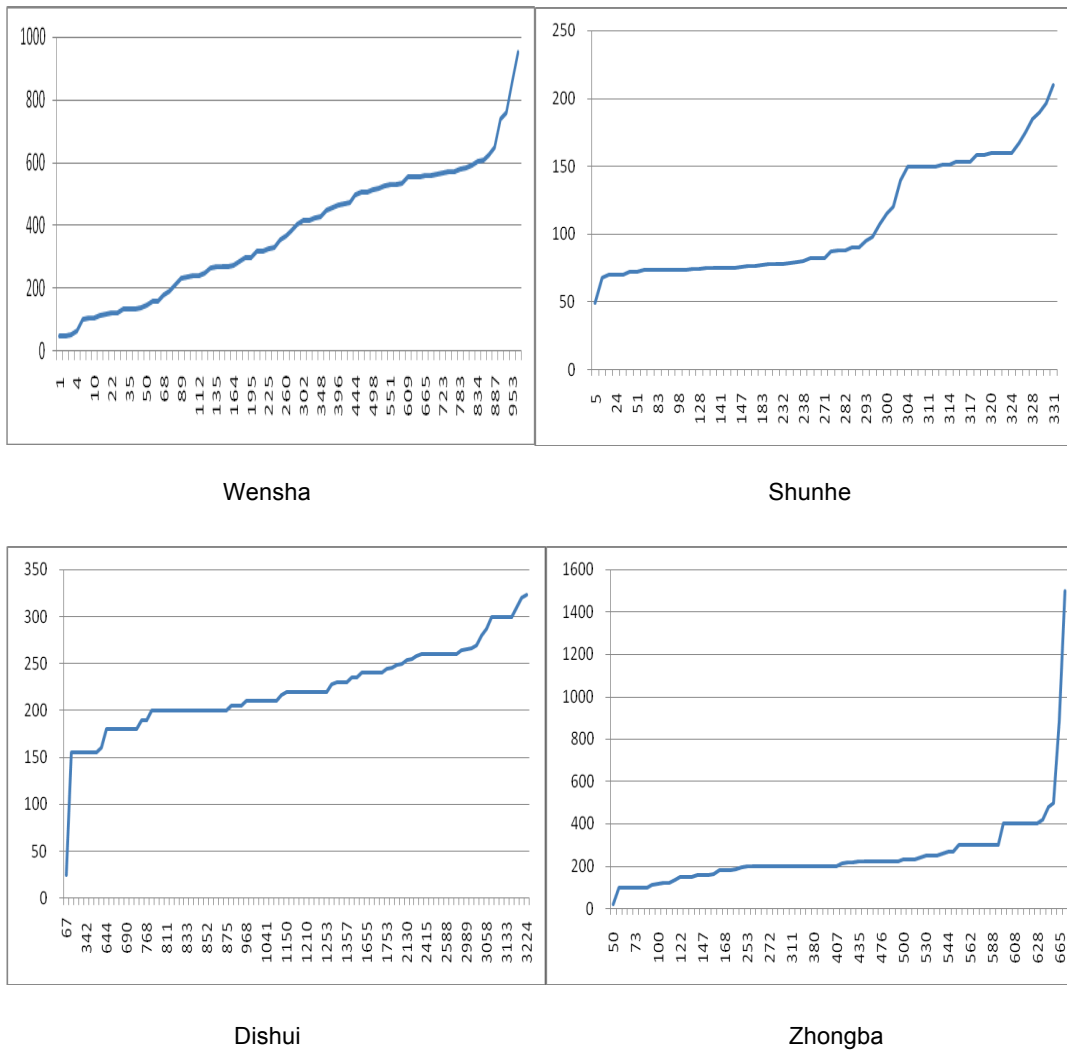


Figure 6: The marginal cost curves of the bidding scheme

Improvements in cost effectiveness of financial resources will not be seen as significant if the transaction costs are taken into consideration. Afforestation under the bidding trial increases some transaction costs compared to afforestation under the CCFGP. All the parties involved in the bidding scheme face different increases in transaction costs. Increases in transaction costs relate to increases in administrative costs for the Sichuan Forestry Department and the

local forest bureaus in project communication and coordination, tender training, organisational and background investigations. Transaction costs at the village level are also sizeable and include costs related to advocacy, mobilization, site survey, organizing bidding, and dispute resolution. Transaction costs for farmers include technical training, afforestation design and management, conservation activities, and producing the tender, etc.

Table 6 Comparison of cost effectiveness between the bidding scheme and CCFGP

	Wenshan	Shunhe	Dishui	Zhongba	Total
Successful bid area ( mu )	985	330.7	851.3	663.2	2825.2
Total Successful bid price (10,000 yuan )	15	2.8	13.2	14.97	45.5
Average price per mu ( yuan )	152.4	84.5	155.1	225.7	161.1
Total subsidy under CCFGP ( 10,000 yuan )	19.6	6.6	17.0	13.3	56.5
Cost saving ( 10,000 yuan )	4.6	3.8	3.8	-1.2	11.0

1mu=0.667ha

Officials from the Sichuan Forestry Department and county forest bureaus have estimated that the transaction costs for the bidding scheme are one third higher than the administrative costs associated with the afforestation under the CCFGP. Hence, if these costs are considered, the improvement of the bidding scheme to cost-effective use of funds is not as obvious. But this figure is compared with the current stage of afforestation under the CCFGP. If compared with the beginning phase the CCFGP, the authorities believed no increase in transaction costs. Farmer participants considered their costs increase, but they also acknowledged that the initial phase of the CCFGP was as difficult as the bidding scheme. In other words, farmers considered the increase in transaction costs of the bidding scheme were rather small. In addition, the scale of the current bidding scheme is also small, so the increase in transaction costs for the improvements in capital efficiency appears higher. With the expansion of the bidding trial, the increase in transaction costs will no longer be significant.

## 5 Discussion and Conclusions

Based on the results of our study on the bidding scheme, the following major conclusions can be drawn and elaborated in this section:

- A market-based mechanism such as a bidding scheme is a feasible approach to ecological restoration and environmental management in China;
- The bidding scheme can improve the use-efficiency of government funds;

- Behavioural change at the local government level is necessary and determines the success of such projects; and
- Transaction costs are an ongoing challenge for the market-based bidding scheme.

Firstly, bidding schemes as a method is feasible for implementing ecological restoration projects in China. Farmers are willing and able to adapt well to a market approach, given there is a real economic incentive and they are appropriately informed. Farmers also welcome the opportunity to emphasize their property rights and make their own decisions concerning the use of their land. The bidding concept is not new and the technology is readily available as they have already been used by the Chinese Government in other public projects. Furthermore, given the potential for improvements in the more efficient use of funds, the Government should be keen to take the advantage of such cost saving opportunities. From a public perspective, a tender process is a more transparent option than the operating mode of previous ecological projects, which have been conducive to social supervision.

Secondly, a tender process for ecological afforestation can improve the use-efficiency of financial resources. It can significantly save financial subsidies while eliminating the net losses of farmers in projects such as the CCFGP. It can be said that it not only embodies the efficiency, but also achieves fairness.

Thirdly, the major difficulties and key part in the bidding scheme is to increase the incentives of local government officials. A lot of work regarding the implementation of the bidding scheme is relied on the local government; however, the delivery of financial resources cannot bring direct benefits for them. Therefore, the local government often resists its implementation due to the thoughts of great workload but without receiving appropriate compensation. It will be a serious consideration to reasonably allocate the financial capital and improve the gains from the ecological afforestation project among different levels of government.

Fourthly, small scales of local farmers' land and their multiple amounts increase the transaction costs of forestation. Future bidding scheme could be implemented at village or township level, which may reduce the transaction costs in the implementation process and further improve the efficiency of financial funds uses. Looking for effective methods to reduce transaction costs is key to a successful implementation of ecological afforestation bidding schemes in the future.

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