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Why Reducing Risk Could Help Drive Forest Carbon Sequestration – A Study from China

One of the key ways in which China is working to tackle climate change is by getting households involved in small-scale forest carbon sequestration (FCS) projects. To help policy makers get more people involved in these schemes, a new EEPSEA study has looked at how the attitudes of households toward risk influences their willingness to participate in FCS projects. It also studied how these attitudes affect the FCS management strategies that households employ.

The study is the work of Zhu Zhen, Shen Yueqin, and Bai Jiangdi from the Zhejiang Agriculture and Forestry University. It finds that households who are risk-averse are more willing to be involved in FSC projects. They also pay more attention to and make higher investments in FCS management projects than risk takers do. The risk-averse, therefore, appear to be the most suitable group of people for FCS projects. The study outlines a number of policies to reduce the risk involved in FCS work. These could be put in place to encourage more households to take part in these important initiatives.

A summary of EEPSEA Research Report No. 2016-RR14: "How the Risk Attitudes of Small-Scale Households Drive Forest Carbon Sequestration Supply: A Risk Experiment in China" by Zhu Zhen, Shen Yueqin, and Bai Jiangdi.
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The FCS Challenge

Since the early 1990s, governmental and nongovernmental organizations around the globe have been developing strategies to tackle climate change. It is widely recognized that forests can play an important role in tackling this challenge by, for example, sequestering and storing carbon.

As the largest developing country in the world, China is currently the biggest global primary energy consumer and carbon emitter. Accordingly, it faces pressures from the international community to reduce its carbon emissions; thus, the country is now working to combat climate change by increasing its forest carbon sink and by developing forest carbon sequestration (FCS) projects.

In the last few years, China has become the country with the largest artificial afforestation area in the world. Thirty-one FCS projects have been developed, about 40% of which are located in the southern collective forest area. One of the main focuses of this work is to engage small-scale households in FCS projects.

The study site – Zhejiang province

Five counties (i.e., Jiande, Longquan, Lin'an, Cangnan, and Kaihua) in Zhejiang province were selected for the study. Zhejiang is in the southern collective forest area of China and contains 6.61 million ha of forestland. All five of the selected counties have plans to develop FCS projects, and two

Wanyao village in Cangnan, Zhejiang province, China. Photo by Gilles Vogt under the creative commons license at https://www.flickr.com/photos/gillesvogt/8359895715/

(i.e., Lin'an and Cangnan) have already introduced regional FCS projects.

Special technological standards for FCS projects in Zhejiang have been drawn up. These specify that the land selected for FCS projects should be bare or that it should be a degraded forestland. Likewise, trees with good carbon capture capabilities should be chosen for cultivation. Using chemical pesticides and herbicides is not encouraged. In addition, FCS work must be monitored continually over time.
Any activities (eg., thinning and using machinery to cultivate the forest, transport seedlings, and timber) should be recorded along with the annual net carbon sink value of the trees that are being grown.

Chinese fir is the main timber wood in Zhejiang, and this species covers about 820,000 ha or 20% of the forest area in the province. Chinese fir has a high carbon storage capacity with a carbon density of about 13.5 t/ha.

Collecting information on FCS management

A total of 200 households spread across the study counties were selected to take part in the survey. Questionnaires were used to collect demographic and socioeconomic data, along with information on the total area of the forestland managed by each household, on Chinese fir management (including input-output data of Chinese fir management in one rotation cycle), and on household perceptions of FCS projects.

Study participants without FCS experience were given detailed information and training on FCS technological standards and management. For example, they were told about the price they would receive for carbon storage of Chinese fir and how their afforestation costs would be affected by the need to abide by FCS technological standards.

The respondents were asked questions such as, "*Would you want to take up FCS and change*

your traditional management choices or practices?" If a household said they would undertake up FCS management, then they were asked, "*How many years can you afford to prolong the rotation age of Chinese fir if required to do so under the FCS project?*"

Assessing households' approach to risk

An experiment was used to assess households' attitudes toward risk. The researchers asked the respondents to make a series of 10 choices that indicated whether they were risk-takers or not. For example, in one choice scenario, they were told that they would have to draw one ball randomly from a collection of two yellow balls and eight white balls. They had to choose between two options. In Option 1, they were told that if they drew a yellow ball, then they would get CNY 20.0; but they would get CNY 16.0 if they drew a white ball. In Option 2, they were told that if they drew a yellow ball, then they would get CNY 38.5; but they would get only CNY 1.0 if they drew a white ball. In this example, risk-takers would choose Option 2.

Once data from the questionnaires, interviews, and risk experiments had been drawn together, the study assessed the forest management decisions that small-scale households made. Subsequently, the researchers looked at how the risk attitudes of the households affected their willingness to participate in FCS projects.

The relationship between risk and interest in FSC

In the risk experiment, 178 households made consistent decisions. Of these, 68 households were risk-takers, 35 were risk-neutral, and 75 were risk-averse.

Most of the households (73.60%) that took part in the study announced that they were willing to take up FCS management. A total of 51 households, accounting for 75% of the risk-takers group, were willing to take up FCS management, while 61 households (81.33%) from the risk-averse group were willing to do so.

Analysis showed that a household's risk attitude was a significant determinant in its willingness to participate in an FCS project. Households that were found to be risk-averse were more likely to participate.

Table 1. Descriptive statistics of willingness to participate in an FCS project

Types	Variables	Unwilling	Willing	Uncertain	Total
Total	Frequency/person	38	131	9	178
	Percentage	21.35	73.60	5.05	100%
Risk-takers group	Frequency/person	16	51	1	68
	Percentage	23.53	75.00	1.47	100%
Risk-neutral group	Frequency/person	10	19	6	35
	Percentage	28.57	54.29	17.14	100%
Risk-averse group	Frequency/person	12	61	2	75
	Percentage	16	81.33	02.67	100%

This can be explained by the finding that risk-averse households do not have many different means of livelihoods. Thus, they usually pay more attention to their traditional source of livelihood, namely, forest management. It was also found that this group believed that the return on investment from FCS is stable, and that it can provide a valuable extra source of income alongside the benefits they get from harvesting timber from their forestland.

The number of plots owned by the households had a significant positive impact on their willingness to undertake FCS. Households that depended more on off-farming income were less willing to participate in FCS management (these were generally risk-takers).

How families manage their forestland

Chinese fir management and off-farming incomes accounted for 70% of the total income of the households that took part in the study. The average income of the risk-takers group was 20.67% higher than that of the risk-averse group. The former's off-farming income was 18.26% higher than that of the latter.

The average forestland size managed by small-scale households was about 4.28 ha, but 62.02% of the respondents had less than 1.30 ha. The average size of the forestland managed by risk-takers was 26.79% larger than that managed by the risk-averse group. This is because the risk-takers had a more aggressive Chinese fir management strategy and contracted additional forestland.

Compared with other groups, the risk-averse group generally enjoyed a higher cost-benefit return from Chinese fir management. In other words, the results indicate that households with risk-averse attitudes are more likely to get a better outcome from Chinese fir management than the other groups would.

Optimal rotation periods for Chinese Fir management

The study found that when its carbon sequestration value was taken into account, the optimal rotation length for Chinese fir is 28 years. This was identical to the optimal rotation length when only the tree's timber value was taken into account.

Likewise, analysis showed that the optimal rotation age and FCS per hectare did not change significantly unless there was a significant change in the carbon price, discount rate, and management costs. This was the case for all three risk attitude groups. The main reason for this was that the timber price was much higher than the current carbon price. This means that the benefits in changing the rotation age are so small that it provides no motivation for households to change their current forest management regimes.

FCS performance

The planting densities of the risk-averse, risk-neutral, and risk-takers groups were 3,256 plants per hectare, 3,073 plants per hectare, and 2,971 plants per hectare, respectively. Due to these different planting densities, the different groups achieved different levels of carbon sequestration. The risk-averse group could supply a maximum FCS of 564.7 t/ha, the risk-neutral group could supply 532 t/ha, and the risk-takers group could provide FCS of 515.18 t/ha.

Overall, the risk-averse group paid more attention to and made higher investments in FCS management than the other attitude groups did. Thus, the risk-averse group appears to be the most suitable group for FCS projects.

Reducing risk to make FCS more attractive

The study shows that risk-averse households would provide higher FCS per hectare. However, it is difficult to identify risk-averse households in real life. One potential indicator is provided by the finding that small-scale households whose livelihood comes mainly from forestry tend to be risk-averse. In light of this, the government should pay more attention to this type of household and encourage them to take up FCS.

One effective way to do this would be to introduce more FCS projects and give FCS training to households that show themselves to be risk-averse. In addition, forestland owned by risk-taking households (e.g., those that have migrated out of an area or who depend highly on off-farming income) could be contracted out to other more risk-averse households that want to expand their forestland and take up FCS.

FCS projects are a great opportunity for developing countries with rich forest reserves. A set of products should therefore be provided by insurance companies to reduce the management risks involved in long forest rotations. This would make FCS more attractive to risk-averse households. In addition, governments should provide several kinds of subsidies for households that want to purchase such insurance schemes.

There are many tree species that are suitable for FCS management. Future research should therefore be done to assess how the risk attitudes of individuals affect the selection of different tree species for FCS projects. Also, it will be necessary to develop further policies and market services to further reduce the risks involved in participation in FCS projects.

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