Farmers' Willingness to Pay (WTP) for Reducing Agricultural Non-point Source Pollution: Based on the Empirical Analysis of 453 Farmers

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Abstract With the rapid development of modern agriculture, agricultural non-point source pollution becomes increasingly serious in China, improving farmers' environmental protection consciousness plays a very important role in the reduction of agricultural non-point source pollution, and the WTP of Farmers for controlling agricultural non-point source pollution strongly reflects the strength of their environmental protection consciousness. Therefore, this investigation and study choose rural areas of five counties from Chongqing city and Zhejiang province as our sample, respectively make interview survey with the WTP (money or voluntary work) of farmers for improving local water and soil quality. Based on the statistical analysis of survey data, this study also takes empirical test and analysis with the influence factors on the WTP of farmers for reducing agricultural non-point source pollution. The analysis and conclusions of this research provides the supports in theory and practice for optimizing farmers' behavior, promoting the management of agricultural non-point source pollution and implementing new rural construction goal.

Key words Agricultural non-point source pollution, Willingness to pay(WTP), Environmental protection consciousness, Contingent valuation method (CVM)

The rapid development of modern agriculture with the improvement of agricultural intensification and promoting economic development at the same time, also brings more severe damage to ecological environment than traditional agriculture. The destruction of agricultural ecological environment is changing from "point source pollution" to "non-point source pollution", agricultural non-point source pollution has become the largest non-point source pollution of environmental problems in our country. For agricultural non-point source pollution, many experts agree: the main reason of serious environmental pollution is environmental protection consciousness is not enough (Whittington D., 1998; Venkatachalam L, 2004; Hu Xinliang, *etc.*, 2011; Yan Chang *etc.*, 2013)[1-4].

Therefore, changing farmers' traditional concept, improving environmental protection consciousness has a substantial effect to the reduction of agricultural non-point source pollution. From subject angle, for improving environmental protection consciousness of farmers, previous research mainly involved propaganda and education to the masses of farmers from government and rural self - discipline organization, but the research on consciousness of farmers who are the subject of agricultural non-point source pollution is relatively lack, such as whether they are willing to reduce agricultural non-point source pollution and how much power they are willing to devote themselves to the mitigation of agricultural non-point source pollution, *etc.*

Farmers' willingness to pay for agricultural non-point source pollution strongly reflects the strength of their environmental protection consciousness, therefore, this article takes the way of questionnaire interview to farmer household, through understanding of farmers' willingness to pay or time duration as volunteers for improving water and soil quality, we take statistical analysis of the cognition degree on agricultural environmental protection consciousness. And using empirical research methods, we analyze what factors affect their payment choice behavior of agricultural non-point source pollution. These conclusions provide the supports in theory and practice for optimizing farmers' behavior, promoting the management of agricultural non-point source pollution and implementing new rural construction goal.

Thus we can gradually solve the problem that agricultural non-point source pollution has become increasingly serious from the emission source of agricultural non-point source pollution.

1 Contingent valuation method (CVM) and questionnaire design

Contingent valuation method (CVM) is a kind of research method. Using the way of questionnaire survey, it reveals the preference of consumer for environment goods and services by simulating the market, and inferences consumers' willingness to pay, so as to assess non-market economic value of public goods.

The value evaluation method for environmental public goods is varied, but research from domestic and foreign shows that evaluating non-market value public goods such as rural environment af-

Received: May 20, 2014 Accepted: July 2, 2014
Supported by Key Research Project of Humanities and Social Sciences in Chongqing.
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fected by agricultural non-point source pollution, willingness survey method is the most likely or the most commonly evaluation methods. Willingness survey method in essence shows how many private goods they are willing to replace public goods when different consumer goods bring them the same utility (Li Haipeng, 2007)[5].

The key to success of CVM is questionnaire design. The questionnaire design and survey of CVM is the implementation process of a hypothetical market, through the way of questionnaire survey, we lead respondents into the hypothetical market environment, directly ask their willingness to pay for a public goods, then reveal the consumers' preference to environmental goods and services, and basing on the level of consumers' willingness to pay, we eventually get the non-use value of public goods. Therefore, the quality of questionnaire directly affects the authenticity, reliability of non-use values of public goods.

In this research, in view of the following characteristic, the main emitters of agricultural non-point source pollution are farmers, the main pollution area is in rural, our investigation objects are mainly farmers. We mainly investigate farmers' willingness to participate in rural environmental protection, and farmers can choose to take part in voluntary labor or to donate money for improving rural environment according to their own family situation.

2 Investigation way and statistical analysis on farmers' willingness to pay

2.1 Investigation way Considering of cost and recycle, this study adopts field survey method, survey sites includes a few villages of Beibei, Hechuan, Fengdu, and Shizhu in Chongqing city and Wenzhou in Zhejiang province. This research adopts random sampling method in sample selection, to ensure the fairness of samples, we extract one person every five people who are willing to accept interviews, but interviewee should have independent economic ability and the age is over 18.

In investigation, in order to be close to the present situation of farmers, on the choice of the way to reduce agricultural non-point source pollution, we only design two ways including paying money or taking part in voluntary work. When treat the protest samples, a vast majority of CVM studies usually get rid of protest samples during data analysis, which results in significantly high WTP estimates (Liang Shuang *etc.*, 2005; Zong Mingxu, 2013)[6-7].

Economic conditions is usually the major cause of zero payment samples, therefore, in our study, in addition to money, farmers can also choose to take part in voluntary work, the purpose is to reduce the possibility of zero payment samples. This investigation withdraws a total of 453 valid questionnaires, among them, Beibei, Hechuan, Fengdu, Shizhu in Chongqing city are respectively 120, 98, 65, 57, and Wenzhou in Zhejiang province is 113.

2.2 Statistical analysis on farmers' willingness to pay for reducing agricultural non-point source pollution Controlling agricultural non-point source pollution needs human, material and financial resources, how many farmers are willing to pay money for it or take part in compulsory labor? In WTP survey of improving water quality, 60.93% of farmers (276) are willing to pay a fee for improving water quality or participate in a certain time of volunteers, but there are still nearly forty percent of farmers refuse to do nothing for improving water quality; in WTP survey of improving soil quality, 67.99% of farmers (308) are willing to pay a fee for improving water quality or participate in a certain time of volunteers, more than thirty percent of farmers refuse to do nothing for improving water quality.

Table 1 shows the cause of farmers' refusing to pay for improving water and soil quality, we can see, in the survey on the WTP for improving water quality, the real reason that farmers choose C is due to economic reasons, in further inspection survey, we find that most farmers in this part are willing to participating in volunteer work. In addition, farmers who choose D are not reluctant to pay, just be afraid that money can't be reasonable use. So, if we classify the farmers who choose C and D into the group who are willing to pay, the proportion will be more than 81.02%, which shows that the environmental awareness of majority farmers is strong.

In the WPT survey for improving soil quality, likewise, we classify farmers who choose C and D into the group that willing to pay, the rate of WTP is: 77.92%, which is similar to the WTP of water quality protection, the majority of farmers are still willing to improving rural environment around them with their money or voluntary work.

Table 1 Survey distribution table on farmers' refusing to pay for improving water and soil quality

	Items	Frequency	Percentage
Improving water quality	A. water conservation is not important, I can't benefit from it.	41	9.05%
	B. water conservation is government affair, it has nothing to do with me.	42	9.27%
	C. having no spare time and money to pay for protection fee.	154	34.00%
	D. don't believe that government can use the funds reasonably for water conservation.	213	47.02%
Improving soil quality	A. protecting land may reduce yield and income.	43	9.49%
	B. I only have the right to use, soil conservation is government affair.	55	12.14%
	C. having no spare time and money to pay for protection fee.	122	26.93%
	D. don't believe that government can use the funds reasonably for soil conservation.	231	50.99%

Which should play a major role in protection of rural ecological environment, government or farmers? 46% of farmers consider that government should play a leading role, and farmers participate in; 28% of farmers consider farmers play a leading role, govern-

ment is complementary; 26% of farmers think they should join together.

There is no denying the fact that the public utilities of environment protection that have positive externalities, its capital demand is big and its effective period is long, the power of individuals and organizations are not compared with government. So we think government should play the leading role, with the power of the states to stimulate the enthusiasm of farmers to participate in rural ecological environment protection, which can make the work carried on better, so as to achieve good results.

The distribution of farmers' WTP is shown in Table 2, Table 3, Table 4 and Table 5.

The WTP of farmers for improving water quality and soil conditions is shown from Table 2 to Table 5. As can be seen from these tables, in the way of donation in WTP of farmers for improving water and soil quality, the rate of farmers who are willing to pay less 20 yuan are both accounted for more than 70%; in the way of volunteer work for improving water and soil quality, both more than 80% of farmers are willing to work less than 5 days for improving environment, in the way of donation, all the farmers of two survey items don't want to spend more than 50 yuan to pay for the money, this may still has a lot to do with their income level, relative to money, work may be more easily accepted by farmers.

On analysis of the WTP for improving water and soil quality, there is another factor should be considered, when designing questionnaire, in order to learn whether there is a difference in the WTP of farmers for different environmental elements in detail, we divide environmental elements into two aspects, water and soil. If we inspect both them together, farmers may not be willing to pay sum of them.

Table 2 Sample distribution table of the WTP for improving water quality (selecting donation form)

Serial number	WTP per year	Frequency	Percentage//%	Serial number	WTP per year	Frequency	Percentage//%
1	0 – 20 yuan	353	77.92	3	50 – 100 yuan	0	0.00
2	20 – 50 yuan	100	22.08	4	More than 100 yuan	0	0.00

Table 3 Sample distribution table of the WTP for improving water quality (selecting voluntary work form)

Serial number	WTP per year	Frequency	Percentage//%	Serial number	WTP per year	Frequency	Percentage//%
1	Less than 2 days	286	63.13	3	5 – 10 days	63	13.91
2	2 – 5 days	104	22.96	4	More than 10 days	0	0.00

Table 4 Sample distribution table of the WTP for improving soil quality (selecting donation form)

Serial number	WTP per year	Frequency	Percentage//%	Serial number	WTP per year	Frequency	Percentage//%
1	0 – 20 yuan	331	73.07	3	50 – 100 yuan	0	0.00
2	20 – 50 yuan	122	26.93	4	More than 100 yuan	0	0.00

Table 5 Sample distribution table of the WTP for improving soil quality (selecting voluntary work form)

Serial number	WTP per year	Frequency	Percentage//%	Serial number	WTP per year	Frequency	Percentage//%
1	Less than 2 days	305	67.33	3	5 – 10 days	32	7.06
2	2 – 5 days	116	25.61	4	More than 10 days	0	0.00

3 Influence factor analysis on the WTP of farmers for reducing agricultural non-point source pollution

Willingness to pay (WTP) shows that their payment of respondents for a certain environmental improvement measures. Through WTP, the psychological tendency people converts into real economic activities, the size of WTP reflects the strength of people's environmental consciousness.

For analyzing the effect that environment consciousness on agricultural non-point source pollution, we reasonably assume to replace environmental consciousness by the WTP of farmers for reduce agricultural non-point source pollution. For further analysis of the main factors influencing farmers' environment consciousness, using multiple linear regression method, we make the correlation analysis between farmers' social economic background factors and their WTP for reducing agricultural non-point source pollution.

According to the mentioned above and considering the availability of relevant data, the model of this study is as follows:

$$y = \alpha_0 + \alpha_1 X_1, \cdots + \alpha_n X_n + \xi,\ n = 1, 2, \cdots, 6.$$

where y is the WTP of farmers, $X_1, \cdots, X_n$ is farmers' characteristic, including 6 elements: the number of farm family, the number of farm workers, the age of householder, cultural degree of householder, farmers' income per year, the cultivated land of farmers; ξ is random disturbance factor.

Taking the survey data of 453 farmers in Chongqing and Wenzhou as samples, using Eviews 6.0, we respectively make regression estimation the influence factors of farmers' WTP for improving water and soil quality. The results are shown in Table 6 and Table 7.

The regression results of Table 6 and Table 7 show that:

(i) The relationship between number of farm households and the WTP for improving water quality is not significant. The relationship between number of farm households and the WTP for im-

proving soil quality is significant positive correlation at 1% level, and its coefficient is maximum in various factors, as the number of farm households increases, farmers pay more attention to land resources, are willing to pay higher fees for improving soil quality.

Table 6 The regression results of influence factor on the WTP of farmers for improving water quality

Variable	Regression coefficient	Standard deviation	T – test value	Significant level
C	−0.4941***	0.154	−3.454	0.000
Number of farm family	−0.0122	0.026	−0.069	0.842
Number of farm workers	−0.0821	0.022	−0.416	0.645
Age of householder	0.0851***	0.003	3.657	0.000
Cultural degree of householder	0.9576***	0.021	4.781	0.000
Farmers' income per year	0.2483***	0.005	4.259	0.000
Cultivated land area of farmers	0.0581***	0.005	10.041	0.000
Sample size	453			
F – statistics	35.032***			
R2	0.326			
Adj – R2	0.315			

Note: ***, **, *, mean respectively significant at 1%, 5% and 10% level.

Table 7 The regression results of influence factor on the WTP of farmers for improving soil quality

Variable	Regression coefficient	Standard deviation	T – test value	Significant level
C	−0.4162**	0.146	−2.955	0.004
Number of farm family	0.7616***	0.016	4.925	0.000
Number of farm workers	−0.0002	0.017	−0.007	0.977
Age of householder	0.0054***	0.003	2.597	0.013
Cultural degree of householder	0.0268	0.007	3.414	0.016
Farmers' income per year	0.0181***	0.007	3.212	0.000
Cultivated land area of farmers	0.0521***	0.006	9.871	0.000
Sample size	453			
F – statistics	37.636***			
R2	0.339			
Adj – R2	0.321			

Note: ***, **, *, mean respectively significant at 1%, 5% and 10% level.

(ii) The relationship between number of farm workers and the WTP for improving water and soil quality are both not significant, and coefficients are both negative, this is a problem that needs further research.

(iii) The relationship between age of household and the WTP for improving water and soil quality is significantly positive correlation, which shows that as the growth of age, farmers hope to have better water and land resources to spend their remaining years in comfort, and it conforms to farmers' psychology. Farmers in China's rural areas have a "home burial" complex, many farmers hope to live in countryside in their old age, and the effect of this traditional thought is profound.

In addition, from the current situation of agricultural production, currently, the group being engaged in agricultural production is mostly older farmers, most young people go to city to work, and agricultural production is a typical physical labor industry, older farmers is not convenient to agricultural production, naturally, farmers hope to have good land and water resources, for increasing agricultural production and incomes.

(iv) The relationship between culture degree of farmer household and the WTP for improving water and soil quality is significantly positive correlation, these results of our study are consistent with our expectations and research of many scholars, which shows that as the improvement of farmers' culture degree, the WTP of farmers also enhance.

This is because the farmers with high education degree have a high enthusiasm to participate in environmental protection, their environment and health consciousness is stronger.

(v) The relationship between farmers' income per year and the WTP for improving water and soil quality is significantly positive correlation at 1% level, this is because higher income farmers can afford more costs for improving environment; on the contrary, if the income of farmers is low, even if their environmental protection consciousness is strong, their economic strength is too weak to bear high environmental costs.

(vi) The relationship between cultivated land area of farmers and the WTP for improving water and soil quality is significantly positive correlation at 1% level, which suggests that the more land farmers possess, the more power they have to improve conditions of water and land with donations or volunteer work.

4 Conclusions

This investigation and study choose rural areas of five counties from Chongqing city and Zhejiang province as our samples, respectively make interview survey with the WTP (money or voluntary work) of farmers for improving local water and soil quality. Based on the statistical analysis of survey data, this study also

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vival rate of artificially planted *Ligustrum lucidum* Ait. , *Liquidambar formosana* Hance and *Ligustrum lucidum* Ait. is high, and they can quickly grow, playing an important role in promoting the vertical development and stability of community.

The major invading plant is herb, and it is based on Asteraceae and Gramineae. The invading shrub species are *Clematis florida* Thunb. , *Akebia trifoliata* and D. orientalis, and the arbor is difficult to invade, possibly because the herb density is too large on the slope, and the indigenous shrub and arbor species are poorly tolerant of poor, acid soils. The artificial planting of seedlings can be used to introduce indigenous shrub and arbor species. The gradient plays an important role in promoting the artificial vegetation restoration. When the gradient is about 45°, in order to ensure the soil thickness of the slope and provide better conditions for the future vegetation restoration, it is necessary to take some additional process to stabilize the slope, and conserve soil and water.

There are no obvious differences in the indicators related to vegetation and soil between the middle and lower slopes, but better than on the upper slope, so it is necessary to artificially plant more seedlings on the upper slope, increase more inputs to the upper slope conservation, and plant more trees and shrubs at top of upper slope to resist rain and other natural disasters, or when conditions permit, appropriately reduce the gradient of the upper slope.

References

[1] TANG J. Pay attention to the social evaluation of the reconstruction work after the disaster[J]. Chinese Cadres Tribune, 2008(6): 10 - 11. (in Chinese).

[2] DENG WJ. The effectiveness and social evaluation of the reconstruction work after the disaster[J]. Sichuan Provincial Conditions, 2008(9): 14 - 15. (in Chinese).

[3] GUO H, YANG N. Review of social evaluation seminar of the reconstruction work after the disaster[J]. Social Science Research, 2008(5): 196. (in Chinese).

[4] LI XY. Pay attention to the social evaluation after the disaster [J]. Sichuan Provincial Conditions, 2008(9): 6 -7. (in Chinese).

[5] Rules of the restoration and reconstruction after Wenchuan earthquake disasters[DB/OL]. (2008 - 06 - 09) . [2011 - 05 - 12]. http: / /www. gov. cn/zwgk /2008 -06 /09/content_1010710. htm. (in Chinese).

[6] WANG QZ, GU B. Preliminary analysis on vegetation restoration scheme in Qingfeng abandoned stone pit of Zhoushan City[J]. Soil and Water Conservation In China, 2006(6): 34 - 36. (in Chinese).

[7] ZHOU ST, GU B, CAI S, *et al*. Application of soil protecting wing technics in restoration of lithoid slope [J]. Bulletin of Soil and Water Conservation, 2009, 29(2): 190. (in Chinese).

[8] SONG YC. Vegetation ecology[M]. Shanghai: East China Normal University Press, 2001. (in Chinese).

[9] YU YH, GU B, AI YW. Analysis of plant diversity of railway cutting slopes in Sichuan Province[J]. Science of Soil and Water Conservation, 2006, 4 (B12): 27 - 30. (in Chinese).

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takes empirical test and analysis with the influence factors on the WTP of farmers for reducing agricultural non-point source pollution.

This survey study finds that farmers have had a fundamental understanding on the harm of agricultural non-point source pollution, and show high enthusiasm in improving water and soil quality. In survey, we also learn that farmers have a lot of confusion with government and related organizations, they think it is difficult to rely on government in this respect, actually, they hope that government will make achievement in control of agricultural non-point source pollution. At the same time, farmers are very practical, they don't believe their donation can be used reasonably, thus they take voluntary work to express their willingness to pay.

In terms of the influence factors on the WTP of farmers for reducing agricultural non-point source pollution, there is positive correlation between the age and culture degree of householder, farmers' income per year, cultivated land area of farmers and the WTP of farmers, that is to say, when the age of farmer householder is older, the education level and farmers' income per year is higher, the cultivated land area of farmers is bigger, the WTP of farmers for reducing agricultural non-point source pollution tend to be much stronger.

The conclusions that come from the statistical analysis of farmers' cognitive degree on agricultural non-point source pollution and the empirical test on the WTP of farmers for reducing agricultural non-point source pollution, provide the support in theory and practice for optimizing the behavior of farmers, promoting the management of agricultural non-point source pollution and implementing the new rural construction goal.

References

[1] Whittington D. Administering contingent valuation surveys in developing countries[J]. World Development, 1998(26): 21 - 30.

[2] Venkatachalam L. The contingent valuation method: a review. Environmental Impact Assessment Review, 2004, 24(1): 89 - 124.

[3] HU XL, XIA PH, HU JW, *et al*. Current status and countermeasures of agricultural non-point pollution[J]. Guizhou Agricultural Sciences, 2011, 39 (6): 211 - 215. (in Chinese).

[4] YAN C, MA T, LUAN JD, *et al*. Analysis on farmers' environmental awareness in Anhui[J]. Journal of Shanxi Agricultural University (Social Science Edition), 2013, 12(5): 453 - 456. (in Chinese).

[5] Li HP. The agricultural non-point source pollution in China: an economic analysis and policy studies[D] . WU HAN: Huazhong agricultural university, 2007. (in Chinese).

[6] LIANG S, JIANG N, GU SZ. The analysis of the WTP of farmers in city water source and its influencing factors: as Miyun reservoir for example [J]. Chinese Rural Economy, 2005(2): 55 - 60. (in Chinese).

[7] ZONG MX, XIA CP. Farmers' willingness to pay for ecological effects and influencing factors——Based on the data from field research in Zhangwan District of Shiyan and Danjiangkou Area[J]. Journal of Huazhong Agricultural University (Social Sciences Edition), 2013(4): 70 - 76. (in Chinese).