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Herders' willingness to accept versus the public sector's willingness to pay for grassland restoration in the Xilingol League of Inner Mongolia, China

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Abstract

This paper describes two payment for ecosystem services (PES) programs to restore grassland ecosystems in Inner Mongolia in Northern China. A key challenge is to sustain the livelihood of local residents, who earn most of their income from traditional animal husbandry. We surveyed 240 herders and 36 government representatives in 2 years. We used contingent valuation and logistic regression to analyze the resulting data. Since the PES implementation, income from cultivation and animal grazing decreased, whereas income from compensation and off-farm activities increased. The herders preferred an annual payment of 625 Chinese yuan (CNY) ha^{-1} for participating in conservation activities, but the government prefers to provide 528 CNY ha^{-1}, resulting in an annual gap of 97 CNY ha^{-1}. The current too-low payments may lead some herders to expand their grazing into restricted grassland or increase their number of animals, particularly if either payment program ends. The herders were most concerned about their economic loss, whereas the government considered both grassland restoration and income protection to be important. To create an improved and sustainable PES scheme, we recommend solutions that will let the herders sustain their livelihood while conserving the grasslands. Our findings will help to establish more effective PES schemes for the grasslands of Inner Mongolia and similar regions.

Keywords: eco-compensation, willingness to accept, willingness to pay, contingent valuation, Xilingol League, Inner Mongolia

1. Introduction

Grasslands located in arid and semi-arid areas are often characterized by high ecological fragility and thus, high

vulnerability to disturbance. There is growing agreement that many ecosystem services in such grasslands are undergoing rapid degradation due to overuse and misuse, and as a result of this trend, grassland degradation and desertification are increasing (MEA 2005). In China, about 54% of the natural grasslands in the arid north are experiencing at least moderate levels of degradation due to the rapid socioeconomic development and population growth that began in the 1980s, and the area of degraded or desertified land has expanded at an annual rate of 2×10^6 ha (Zhao *et al* 2006). Because of the resulting decrease in ecosystem services, this has also hindered regional economic development, jeopardized the livelihoods of residents of the region, and endangered regional ecosystems.

China's Inner Mongolia Autonomous Region is an important base for animal husbandry and an important ecological barrier that conserves water and soil, stabilizes the region's sandy soils against wind erosion, and preserves biodiversity (Yao *et al* 2007). Between 1980 and 2000, Inner Mongolia's population increased by 26%, from 18.76×10^6 to 23.72×10^6 (table 1), while the number of livestock almost doubled, from 12.6 million to 24.2 million animals, mainly sheep. (Unless otherwise noted, all statistics presented in this paper were provided by the Statistical Bureau of the Inner Mongolia Autonomous Region.) The available area of grassland per sheep unit decreased from 6.80 ha in 1950 to 1.27 ha in 2000, and the proportion of degraded grassland now ranges from 19 to 79%. The worst of the degraded grassland areas can be found in the region's Xilingol League, where the population increased by 19%, from 764 000 in 1980 to 909 000 in 2000 (table 1); during the same period, the number of livestock increased by 177%, but the grassland productivity decreased by 30%, and the percentage of degraded grassland increased from 48.6% in 1984 to 64% in 2000, of which about 27.5% is severely degraded grasslands (Li *et al* 2008, Bao 2009). In addition, natural disasters such as heavy snowfall, drought, wind erosion, and insects damaged the already vulnerable grasslands.

This worsening situation has significantly affected the livelihood of local peoples, who have started to look for alternative means to support their living. It is widely believed that damage to the production of economic value and hence material welfare in the form of ecosystem services results from a lack of institutions to guide the supply and demand for ecosystem services (Costanza *et al* 1997, Balmford *et al* 2002). In addition, institutional settings play a key role in shaping land cover and land use (Prishchepov *et al* 2012), which can also influence the provision of ecosystem goods and services. Payment for ecosystem services (PES) has been widely considered to be one useful measure to deal with this problem (CCICED 2007).

To solve these problems and conserve the vast grasslands in its northern territory, the Chinese government has adopted several measures, including PES. This form of eco-compensation payment can be defined as 'a type of institutional arrangement to protect and sustainably use ecosystem services, and to adjust the distribution of costs and benefits between different actors and stakeholders, mainly through economic measures' (CCICED 2007). PES programs internalize the benefits associated with enhancing or maintaining ecosystem services to ensure that land managers and other providers of ecosystem services have incentives that agree with the interests of the users of these ecosystem services (Arrow *et al* 2000, Pagiola *et al* 2005, van Noordwijk and Leimona 2010). There has been an increasing number of publications that describe China's PES program, but most of them focus on the sloping land conversion program (SLCP)—the largest land retirement and reforestation program in the world (e.g., Bennett 2008, König *et al* 2012, Zhen *et al* 2013) SLCP uses a public payment scheme that directly engages millions of rural households as core agents of the project's implementation. Although PES schemes assume that participation is voluntary, and that participants can negotiate a price that is acceptable to them, this is not how the program has been implemented in practice; participation is mandatory. Thus, as Bennett (2008) reported, some participants are likely to be under-compensated (i.e., paid less than they would request if they had freedom to negotiate the bid price). Any gap between the actual payments and what participants would bid if they were free to choose would reveal an important problem with the current approach, since voluntary participation requires what the participants consider to be a fair payment. Xu *et al* (2010) revealed that the program could have significant implications for China's forests and remaining natural ecosystems, potentially representing a 10–20% increase in the current national forest area, a roughly 10% decrease in China's cultivated area, and a significantly positive impact on participant income due to the program's payments. However, it seems likely that the program's cost-effectiveness could be improved by targeting sites with the highest environmental benefits and allowing payments to reflect the heterogeneous opportunity costs faced by residents of the region, while also preventing farmers from reconverting their land to cultivation.

The PES approach has been applied increasingly in both developed and developing countries. Increasing attention has been paid to (1) the concepts, theory, and framework of PES (e.g., Wunder 2005, 2008, CCICED 2007, Engel *et al* 2008, Zhen and Zhang 2011); (2) assessments of the environmental impacts of PES programs (Thornley 1998, Xu *et al* 2006, Munkhtsetseg *et al* 2007, Wu *et al* 2012); (3) institutional and policy aspects that affect how to determine compensation schemes (Ren *et al* 2006, Wang *et al* 2006); and (4) the stakeholders' willingness to pay (WTP) for the PES scheme. In the latter case, examples include WTP for pollution reduction (e.g., Zhen *et al* 2011); for protection of the Tapanti National Park and forestry ecosystems in Costa Rica based on surveys of local residents, tourists, and companies (Bernard *et al* 2009); and for environmental management while developing the economy of China's Tianjin City (Zhai and Suzuki 2008). In addition, researchers have studied (5) the impact of the conservation programs on local peoples, such as the impacts of the presence of working land programs on land retirement in an important agricultural region of the United States (e.g., Kling *et al* 2005), on biodiversity and conservation programs in Europe (e.g., Hawksworth and Bull 2008), on urbanization and agricultural land use in the Netherlands (Vermaat *et al* 2008), and on sedentarization and nomadic culture in China's

Table 1. Demographic information for the study region.

	Population ($\times 10^4$)							
	1980	1985	1990	1995	2000	2005	2010	2012
Xilingol	76.4	82.5	88.9	90.6	90.9	100.6	102.9	103.6
Inner Mongolia	1876.5	2015.9	2162.6	2284.4	2372	2403	2472.2	2481.7

Xinjiang Uyghur Autonomous Region (Fan *et al* 2013) and Inner Mongolia (Bao 2009). However, little attention has been given to the people who are most likely to be affected by a policy's implementation in China in terms of their preferences, perceptions, and willingness to accept (WTA) a PES scheme for protecting grasslands, as well as the public sector's WTP to compensate those affected by PES projects based on the actual changes in their livelihood caused by the project (e.g., Li and Li 2010, Wu *et al* 2012).

In the present study, we analyzed the impacts of a top-down PES program designed by China's central government on the livelihood of herders in the Inner Mongolia Autonomous Region, and examined their preferences for key elements of the PES program design, including the payment type, amount, and means. We also estimated the WTA of the herders and WTP of the relevant government agencies for two local PES programs. First, we describe the PES programs that have been implemented in the region. Next, we assess the impact of these programs on the income structure of the herders based on a survey of households in the regions affected by the program, and the factors that influence this structure and the WTP of local officials. Finally, we discuss the main conclusions that arise from our results and propose recommendations for an improved PES design.

It is important to note that once the Chinese government has designated land for protection under a PES program, participation in the program became mandatory. Thus, our analysis does not consider a hypothetical situation in which residents of the study region have the option of not participating. Instead, the goals of our WTA and WTP analysis were to compare WTA with the actual payments to learn whether these payments are satisfactory, and to compare WTA with WTP to learn whether the government recognizes dissatisfaction among program participants and is willing (budget permitting) to improve their situation. These factors will have important consequences for the long-term effectiveness of the programs.

2. PES programs implemented in the Xilingol League grassland of the Inner Mongolia Autonomous Region

For this study, we selected Inner Mongolia's Xilingol League for a case study (figure 1). Inner Mongolia's population amounted to 24.871 million people in 2012. Agriculture, which is currently the main land use in the Xilingol League, is characterized by small-scale mixed subsistence farming systems with livestock production as an integral part (Zhang *et al* 2007, Zhen *et al* 2010). Grassland is the main land cover type in this region, accounting for 86% of the total land area. In addition to agriculture, mining and related industries are gaining in economic importance. In terms of land ownership, China's land reform began in 1987 and the grasslands in Xilingol were allocated under contract to collectives (*haote* in the local language) that consisted of three to eight families, who shared the contracted grasslands for their grazing. In 1997, the grasslands were contracted to individual families based on the nearness of the land to their settlements, and each family received usage rights for the lands that were defined in a contract signed with the local government. To increase their income and make best use of the grasslands, each family then increased the number of animals they owned; during this period, the total number of sheep increased by 41.4% in Xilingol, from 1727 in 1989 to 2442 in 1999 (Bao 2009). To prevent the animals of other families from entering the contracted grasslands, each individual family built fences around their land, leading to segmentation of the grasslands and sedentarization of the herder families. As a result of the increased pressure on the grassland ecosystem, degradation of the grasslands has been increasing seriously since then (Bao 2009).

Facing increasingly severe grassland degradation, both China's central government and local governments have begun taking a series of countermeasures since 2000 to control this negative trend. These include the *Wind and Sand Source Control Around Beijing and Tianjin Project*, which focuses on afforestation, grassland maintenance, and water conservation as countermeasures; the *Ecological Migration Project*, in which nomadic herders are encouraged to leave ecologically vulnerable areas and settle in stationary settlements where the land has a higher carrying capacity; the SLCP; and the *Grazing Prohibition Project* (GPP). We will focus on the two latter programs in the rest of this section. The common targets of these projects are to restore the ecological condition of the grasslands and to improve the quality of life of the herders. To successfully implement these environmental protection policies, it is necessary to sustain the livelihood of the herders who depend so strongly on grazing their livestock in these grasslands (Chen and Su 2008), especially under the SLCP and GPP, which are important components of PES in the grasslands.

Sloping Land Conversion Project: Since 2002, the government of the Xilingol League has implemented the SLCP in the agricultural and pastoral zone. The project involves converting cultivated land on slopes $>5°$ to forests or grasslands, thereby protecting the vulnerable soil throughout the year. The project covers the whole agricultural region, including 75 890 households and 278 806 persons. By 2008, the total area converted under this program amounted to 170 000 ha. The central government budgeted 2×10^8 Chinese yuan (CNY)

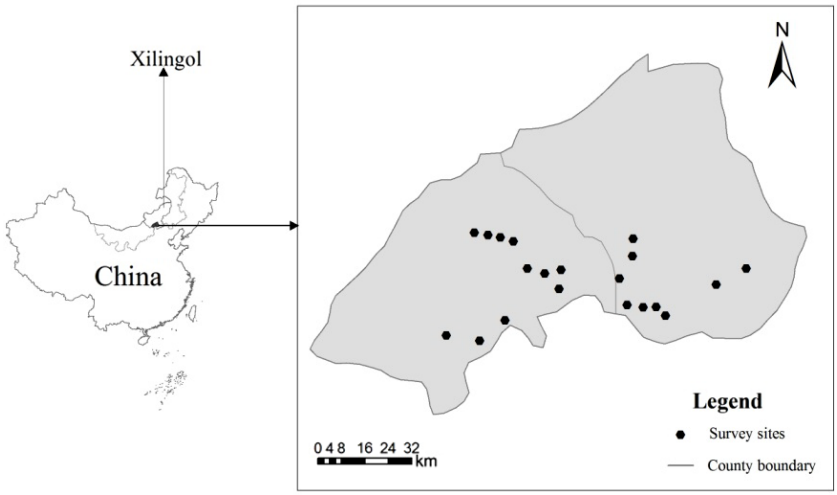

Figure 1. Location of the Xilingol League of the Inner Mongolia Autonomous Region in China, and locations of the survey sites.

annually for the project, representing an annual compensation of about 2100 CNY ha^{-1} or 717 CNY per capita (Xilingol Ecological Monitoring Station 2008).

Common vegetation such as *Caragana korshinskii* Kom. (a shrub species) and *Salix alba* var. *tristis* (a fast-growing willow) were planted on the converted land, with survival rates of about 85 and 81%, respectively, after 8 years. The coverage by forests and converted grassland increased from 45% in 2000 to 70% in 2008. The total area converted to forests amounted to 160 000 ha, of which 75% were ecological restoration forests.

Grazing Prohibition Project: China's central government launched this project to optimize the utilization of grassland resources. The project area covered 10.351×10^6 ha, which amounts to 54% of the total grassland in the Xilingol League. The project had a budget of 1.59×10^8 CNY from 2002 to 2007, and covered 56 towns and 582 villages, with a total of 56 228 households. The project includes three sub-measures: grazing prohibition, resting of the grazing land, and rotational grazing. Grazing prohibition requires the installation of livestock fencing and bans livestock from badly degraded areas for long periods to allow recovery of the vegetation. Resting of the grazing land means breeding the livestock indoors or in a fenced pasture for 40–60 days during the spring season to prevent grazing of the grass plumules, thereby allowing them to recover. Rotational grazing is a livestock production system in which livestock graze in one portion of a pasture that has been divided into several paddocks. Livestock are systematically moved from one paddock to another based on the growth of the forage. The current annual compensation awarded to herders is about 95 CNY ha^{-1} under grazing prohibition, about 9 CNY ha^{-1} for resting the land for 1–2 months per year (from mid-April to mid-June), about 25 CNY ha^{-1} for having fewer animals per ha than the amount defined locally (i.e., 1.7 ha for one sheep unit) to avoid overgrazing, and 150 CNY ha^{-1} for using improved grass species to improve local fodder production. Thus, the current maximum amount paid to the grazing prohibition herders is about 270 CNY ha^{-1} (because the 9 CNY ha^{-1} for resting the land cannot be received simultaneously with the 95 CNY ha^{-1} for grazing prohibition). This is far lower than the standard SLCP payment, in part because the area of grassland is much larger than the area of sloping land that is owned by the herders (table 2).

3. Data and methodology

We obtained information from both secondary and primary sources. Secondary information was derived from national and local statistical yearbooks and documents provided by various government agencies such as the Statistics Bureau, Bureau of Agriculture and Animal Husbandry, Bureau of Land Resources, Bureau of Forestry, and Monitoring Station of Grassland Ecosystem. Primary information was collected through household surveys at the sites shown in figure 1. Selection criteria for these sites included the dominance of livestock and agriculture production in local economic development, location in a potential sandstorm source area that affects Beijing (China's capital), and location in a region where both the SLCP and the GPP have been implemented.

3.1. Surveys

3.1.1. Household survey. Based on these criteria, we used stratified random sampling (Weber and Tiwari 1992) to select the villages in our study. In this process, we specifically included villages that differed in terms of characteristics such as income levels, number of animals raised (primarily sheep and cows), and the distances to the nearest main road and to the capital city of the county. We selected 20 survey sites in 10 villages from 7 townships (figure 1). We then used simple random sampling (Weber and Tiwari 1992) to select 240 households (ranging from 21 to 35 per village) to answer our questionnaire, which amounted to a total of 135 herding households and 105 farming households. These families represented 68–82% of the households in the selected villages. Our surveys were conducted from October to

Table 2. Proportion of total land resources accounted for by converted sloping land and the area in which grazing is prohibited.

		Area (ha/household)					
		Before project		After project		Land area affected[a]	
Program	No. of households	Cultivated land	Grassland	Cultivated land	Grassland	Converted	Grazing prohibited
Grazing prohibition project	79	0.20	89.3	0.20	53.6	0	35.7
Sloping land conversion project	105	1.18	17.1	0.47	17.1	0.71	0
Both projects	56	1.08	98.3	0.73	78.2	0.35	20.1

[a] 'Converted' refers to the area of cultivated land converted into natural grassland or forest. 'Grazing prohibited' refers to grassland area in which grazing is prohibited and the land is protected to allow recovery.

November 2008, and from July to August 2012. The villages that we visited were loose collections of households, scattered through a large area of pasture. Since there were no obvious pathways through the villages, we started at one end of the area of pasture and walked through the village area until we had spoken with representatives of a sufficient number of households per village. We asked the head of each household or a family member who was familiar with the household to answer our questions. To ensure correct understanding of the questions, we hired two to three local people (from the Mongolian ethnic group) to help us translate during the interviews. Completion of a questionnaire required 1–1.5 h.

Prior to the formal surveys, we conducted an informal preliminary survey using individual interviews and group discussions with herders and key informants to test our questions and increase the validity of the results. The information collected in this informal survey helped guide our development of the formal questionnaire that we used to collect our data. The interviews included questions in the following areas: (a) the socioeconomic characteristics of the households, which related to the household composition, levels of education, land and livestock owned, and income structure. (b) Their WTA compensation for grassland conservation, and the preferences for key elements of the PES programs such as how to determine the standard payment, the source of the payment funds, and the means of payment. We primarily used closed-ended questions, but added open-ended questions where there was an opportunity to expand on certain topics during the interview.

3.1.2. Government survey. In China, PES projects are initiated by the government. We interviewed representatives of local government agencies involved in grassland conservation using pre-prepared questionnaires to learn about their WTP for grassland protection. The questions were designed to determine how much they believed that households should be paid for protection of grassland resources through grazing prohibition and rotational grazing, with the goal of maintaining the household's livelihood. In addition, the surveys gathered information about the standard payment rate, source of the payment funds, means of payment, and their perceptions of the current payment schemes.

All relevant local government agencies were selected for the survey: the Xilingol Development and Reform Commission, Xilingol County Council, Statistics Bureau, Bureau of Agriculture and Animal Husbandry, Bureau of Land Resources, Bureau of Forestry, Xilingol Grassland Monitoring Station, Ecological Management Office, Station of Forest Management, Bureau of Environmental Protection, Bureau of Water Resources, Inner Mongolian Grassland Monitoring Station, and Inner Mongolian Normal University. Altogether, we interviewed 36 officials from 13 government departments. Each questionnaire took about 40 min to complete.

3.1.3. Statistical analysis. We analyzed the impact of PES on the income structure of the households affected by the projects, and their knowledge, perceptions, and WTA, using version 16.0 of the SPSS software (SPSS Inc., Chicago, IL). Specifically, we calculated descriptive statistics (mean values, standard deviations, and percentages for land use and perceptions), and used independent-sample t-tests to identify significant differences between groups. We also used multinomial logistic regression to analyze the relationships between WTA and household characteristics. We performed similar analyses for the WTP of government officials.

3.2. Calculation of WTA and WTP

Willingness to accept (WTA) represents the minimum amount that a person is willing to accept to abandon a good or to tolerate something negative, such as pollution. In our study, WTA represented the amount a respondent was willing to accept to limit grazing and in exchange for an improvement in environmental quality (e.g., conservation of grasslands, water, and soil, and reduced grassland degradation) through the PES programs. Willingness to pay (WTP) represents the maximum amount that an individual is willing to sacrifice to procure a good or avoid something undesirable. A government official's WTP represents the amount they believe would represent a fair payment, which may differ from the amount they are actually able to pay based on the budget they have available. Combining WTA with WTP is particularly useful when the goal of a study is to determine whether those who pay and those who accept the payments have reached a satisfactory compromise that meets both of their needs.

We used the contingent-valuation method (CVM) to quantify each household's WTA and each government official's WTP for grassland conservation. CVM is a kind of stated-preference approach that employs a hypothetical market system to extract WTA or WTP values for environmental goods

(Hadker *et al* 1997, Carson 2000). CVM has become one of the most widely used valuation techniques due to its flexibility and its ability to estimate total values (e.g., Hanemann 1984, 1989, 1994, Spash and Hanley 1995, Bjornstad and Kahn 1996, Liu and Zhen 2007, Spash *et al* 2009). Existing methods for estimating WTA or WTP include continuous CVM (represented by open-ended questions) and discrete CVM (represented by dichotomous-choice questions). In continuous CVM, the interviewees are free to answer the open-ended questions by defining the maximum amount they are willing to pay. This also facilitates analysis of the data. The disadvantage is that it is sometimes difficult for the interviewees to give the appropriate answer when they don't have enough background information about the research subject or when they are actually not sure of the maximum amount they are able to offer or the minimum amount they are willing to accept when they have to do so Loomis and Walsh 1997. In contrast, discrete CV lets the interviewees express their WTP or WTA by choosing either 'yes' or 'no'; thus, they don't need to indicate the specific amount, and this can avoid the problem of inconsistency between the stated and actual values (Hoehn and Randall 1987).

The most persistently troubling empirical result in the CVM literature is hypothetical bias, the tendency for the hypothetical WTP to overestimate the real WTP (Cummings *et al* 1995, 1997, Blumenschein *et al* 1997). Critics of CVM often claim that responses about WTP or WTA will be different for hypothetical versus real choices, and that, for instance, respondents will actually pay less (Whitehead and Cherry 2007). A meta-analysis by Murphy *et al* (2005) found a median difference of 35% between the hypothetical and actual WTA or WTP, and this difference may relate to how respondents define the value of the good or service Murphy *et al* (2010). Many studies have addressed ways of overcoming the biases created by this phenomenon. For example, the dissonance-minimization techniques proposed by Blamey *et al* (1999) and Loomis *et al* (1999) allow the respondent to choose an option such as 'I support the [program]. . . but it is not worth [value] to me'. This is likely to be effective if the bias is predominantly caused by management of the impressions of the respondents. On the other hand, the popular cheap-talk and budget-reminder technique (Whitehead and Cherry 2007) may encourage the respondent to think twice, which may be more effective in alleviating the bias than dissonance-minimization approaches, which proved to be more effective than dissonance-minimization approaches in alleviating the bias for a reforestation program (Krawczyk 2012).

Whitehead and Cherry (2007) found that both ex-ante and ex-post approaches can successfully mitigate and even eliminate hypothetical bias because they addressed the bias in the survey using one or more follow-up questions. In a recent study, Kim *et al* (2012) examined how accounting for the hypothetical bias affects the WTP for preservation of an endangered species from two different samples of respondents who were separated by distance (and costs) from the species' location. Mjelde *et al* (2012) noted that four factors may be related to the bias: income, environmental awareness, age, and familiarity with a good. Increasing any of these factors will reduce the potential bias.

To gain the data required for WTA and WTP, we used a single-bounded dichotomous CVM method. To mitigate the hypothetical bias, we used preliminary surveys and follow-up questions to determine the potential WTA and WTP for grassland conservation for the herders and the government officials respectively. We obtained the ranges for WTA and WTP from the preliminary surveys, and revised the questionnaire to mitigate this bias during the formal survey. The formal survey started with a description of the purpose of the survey to participants, continued with gathering of basic demographic data, and concluded with questions intended to reveal the participant's WTA for not overgrazing or not grazing in specific plots, based on the expected annual bid values (75, 150, 300, 450, 750, 1050, 1350, and 1500 CNY ha^{-1}; 1US$ = 6.3417 CNY in April 2013). The expected bids were determined based on a preliminary survey of the income losses that resulted from land conservation and based on pre-interviews with local people and government officials. In each questionnaire, the respondent was asked a follow-up question such as the following: 'If grazing activities are restricted to conserve grasslands and your financial losses should be compensated, would you be willing to accept/pay [amount] for the economic loss/conservation to meet this end? (yes/no)'. Respondents who answered 'yes' to the question were then asked to indicate their willingness by choosing either yes or no in response to the corresponding bid value. Because the bid values were based on the direct income loss from grazing restrictions and estimates by government officials, we hypothesized that the hypothetical responses would be close to the real choices. However, this hypothesis should be tested in future research.

For our analysis of WTA, we applied a logit model (Hanemann 1984) to reveal the relationship between the respondent's willingness to accept a bid ('yes' or 'no') and the corresponding bid value (based on data from the preliminary surveys). The standard form of the model is as follows:

$$\text{Prob} = 1 - \{1 + \exp[B_0 - B_1 x]\}^{-1} \quad (1)$$

where *Prob* represents the probability of accepting a bid, B_0 and B_1 are regression coefficients, and x is the bid value. The relationship between the bid values and the consensus rate (i.e., the proportion of the households who were willing to accept the corresponding bid value) is shown by the following function:

$$P = 1/(1 + b_0 \times b_1^x) \quad (2)$$

where P is the consensus rate, which represents the percentage of the households who are willing to accept the corresponding bid value, x is the bid value, and b_0 and b_1 are regression coefficients, where $b_0 = e^{-B0}$ and $b_1 = e^{B1}$.

The probability density of WTA is expressed as follows:

$$\rho = -P'(x) \quad (3)$$

where ρ is the probability density of WTA, and $P'(x)$ represents the probability of a WTA value less than x.

To gain the necessary data for WTP, we used the same method that we used for WTA, with the same bid values, which were also determined based on preliminary survey data from pre-interviews with local officials. The interviewees indicated

Table 3. Responses to questions designed to reveal the awareness and attitudes of the interviewees. Variables x_1 to x_{10} represent the parameters in equation (4).

Parameters	Responses	Mean	SD	*B*	S.E.	Wald	df	*P*	Exp (*B*)	β[a]
Education (x_1)	(1) illiterate, (2) primary, (3) secondary, (4) high school, (5) college and above	1.92	0.91	0.126	0.443	0.081	1	0.077	1.134	0.031
Employment (x_2)	(1) grazing, (2) farming, (3) off-farm, (4) house, (5) student	1.78	0.64	0.226	0.683	0.109	1	0.047	1.253	0.085
Land area (x_3)	Land area (66.7 ha)	0.14	0.12	−0.231	2.244	2.074	1	0.000	5.306	−0.285
Land renting (x_4)	(1) none, (2) rent to someone else, (3) rent from someone else	1.68	0.93	−0.025	0.244	0.01	1	0.091	0.976	−0.003
Income (x_5)	Total annual family income ($\times 10^4$ CNY)	1.68	1.64	0.069	0.138	0.249	1	0.160	1.071	0.005
Subsidy (x_6)	Total annual government subsidy ($\times 10^4$ CNY)	0.27	0.32	−0.406	0.749	3.524	1	0.005	0.245	−0.167
Awareness of payments for ecological services (x_7)	(1) Yes, (2) No	1.58	0.49	0.107	0.476	0.051	1	0.082	1.113	0.028
Conservation policy (x_8)	(1) Satisfied, (2) Not satisfied, (3) No opinion	1.19	0.39	0.151	0.506	5.174	1	0.052	3.163	0.042
Willingness to participate in conservation (x_9)	(1) Willing, (2) Not willing	1.32	0.46	0.876	0.475	3.404	1	0.006	2.401	0.229
Accessibility (x_{10})	Distance from homestead to county seat (m)	1620	2940	−0.049	0.035	2.044	1	0.26	0.952	−0.001

[a] β is the standardized coefficient (SC) of the independent variable: $\beta_i = \frac{b_i \times \mathrm{sd}_i}{\pi/\sqrt{3}} \approx \frac{b_i \times \mathrm{sd}_i}{1.8138}$ where β_i is the SC for independent variable i; b_i is the non-standardized coefficient for independent variable i; and sd_i is the standard deviation of independent variable i.

their willingness to pay a certain bid by choosing either yes or no in response to the corresponding bid value, which can help to avoid the problem of inconsistency between the stated WTP and the actual amount they are able to pay (Hoehn and Randall 1987). We also used equations (1)–(3) to calculate WTP, but with WTA replaced by WTP and with the household replaced by the government department in each equation.

We analyzed the factors that influenced the herders' willingness to accept PES schemes (equation (4)) using multinomial logistic regression, with significance at $P < 0.05$, and we used the Wald test to determine whether the partial regression coefficients of the independent variables equaled zero. The resulting equation was:

$$\begin{aligned} y = & -0.475 + 0.126x_1 + 0.226x_2 + 0.231x_3 - 0.025x_4 \\ & - 0.069x_5 - 0.406x_6 + 0.107x_7 + 0.151x_8 \\ & + 0.876x_9 - 0.049x_{10} \end{aligned} \quad (4)$$

where y is the WTA for the PES scheme, and x_1–x_{10} are the independent variables listed in table 3.

4. Results and discussion

4.1. Characteristics of the respondents

The proportion of male respondents (67%) was higher than that of female respondents (33%), as men are the dominant partner in most of the local families. About 41% of the respondents belonged to the Mongolian ethnic group, and the remaining 59% belonged to the Han ethnic group. Most of the respondents (62.1%) were middle-aged (35–45), and only 6.3% were older than 65 years. The family size averaged about three persons, generally representing two parents and a child. More than half of the respondents (61.3%) were illiterate or had only attended primary school due to difficulty of access to the nearest school and low family income, and only 8% of respondents had a high school education. The average household owned 0.20, 0.47, and 0.73 ha of cultivated land for the households that participated in the GPP, the SLCP, and both programs, respectively, versus 53.6, 17.1, and 78.2 ha of grassland, respectively.

Among the 240 respondents we interviewed, 79 were involved in the GPP, 105 were involved in the SLCP, and 56 were involved in both programs simultaneously (table 2). For each group, we analyzed the change in land resources as a result of the GPP and the SLCP. In the GPP group, grazing prohibition affected 39.9% of the original grassland area (an average of 35.7 ha per household), as the available grassland decreased from 89.3 to 53.6 ha. In the SLCP group, about 60% of the cultivated land was returned to natural grassland or artificial forest, with an average area affected of about 0.71 ha per household; that is, the area changed from 1.18 ha per household before the project to 0.47 ha after the project; this made farming difficult, as the land's productivity is very low due to poor soil conditions. The grassland resource of about 17 ha per household that remained after implementation of the PES programs is able to support 10 sheep or 1 cow according

Table 4. Comparison of the income structure of respondents before and after the payment for ecosystem services programs.

Program[a]	Period	Living cost	Income per household (CNY year^{-1})							
			Cultivation	Sheep	Cattle	Compensation	Allowance	Off-farm jobs	Remittance	Total
Sloping land conversion project	Before	2904.2	1024.5	1413.6	428.0	0.0	0.0	393.5	0.0	3259.6
			(31.4)	(43.4)	(13.1)	(0.0)	(0.0)	(12.1)	(0.0)	(100.0)
	After	5350.5	631.2	2998.0	328.0	1845.7	0.0	2378.9	1820.5	10 002.3
			(6.3)	(30.0)	(3.3)	(18.5)	(0.0)	(23.8)	(18.2)	(100.0)
Grazing prohibition project	Before	4912.3	0.0	9983.6	4038.6	0.0	0.0	189.5	0.0	14 211.7
			(0.0)	(70.2)	(28.4)	(0.0)	(0.0)	(1.4)	(0.0)	(100.0)
	After	7882.5	0.0	12 543.4	3825.9	2648.0	308.5	3428.6	623.1[b]	23 377.5
			(0.0)	(53.7)	(16.4)	(11.3)	(1.3)	(14.7)	(2.7)	(100.0)
Both projects	Before	3800.1	8956.7	2135.5	0.0	0.0	0.0	0.0	0.0	11 092.2
			(80.7)	(19.3)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)
	After	6404.8	9948.0	1923.4	0.0	2424.0	353.3	0.0	0.0	14 648.7
			(67.9)	(13.1)	(0.0)	(16.5)	(2.4)	(0.0)	(0.0)	(100.0)

[a] Average data from household surveys in 2008 and 2012. Because the 2008 and 2012 data did not differ significantly, we used their average for our analysis.
[b] Including 80.6 CNY (0.3%) from rental of mowing machines to produce fodder. 'Remittance' represents money received from migrant workers (family members working and living in the cities). 'Allowance' represents government funds provided to purchase mowing equipment, buy fodder and veterinary medicine, and construct storage facilities for hay or fodder.

to the local standard of 1.7 ha of grassland per sheep unit. In the group that participated in both programs, the available grassland decreased from 98.3 to 78.2 ha, and the area in which grazing was prohibited totaled 20.1 ha (20.4% of the original grassland area); thus, about 0.35 ha of cultivated land per household was converted into natural grassland, and the area of cultivated land per household decreased by 32.4%, from 1.08 to 0.73 ha.

In terms of income, the implementation of the SLCP and of the GPP has changed how the respondents earn their living, which is reflected in the local income structure. Comparing the income structure before and after implementation of the two projects (table 4), we found that the SLCP group depended on traditional crop cultivation, with a relatively low productivity due to the dry weather and impoverished soils. The income from cultivation before implementation of the SLCP was 1024.5 CNY annually, accounting for 31.4% of the total income. The most important income source was small-scale animal husbandry, including 30–40 sheep per household and 1–2 cows; these animals accounted for 56.5% of the farm income (1841.6 CNY annually). After the SLCP, the available cultivated land decreased, and the income from cultivation decreased by nearly half, to 631.2 CNY in 2012, which accounted for only 6.3% of annual income; income from animal husbandry nearly doubled, but decreased to 33.3% of the total annual income. Compensation provided by the government accounted for 18.5% of the total income, and was intended to compensate farmers for their losses caused by limitations on farming and grazing. Many farmers found off-farm jobs in construction, processing of agricultural products, and services in nearby cities or towns, and income from these off-farm jobs accounted for 23.8% of the total; money received from migrant workers (family members working and living in the cities) who sent money back to their parents or relatives at the end of the year or to celebrate a festival ('remittance') also reached 18.2% of the total income.

Total annual income of herders who participated in the GPP (table 4) increased by 65%, from 14211.7 CNY to 23377.5 CNY, as they have been receiving 2648 CNY annually from the government, which is equivalent to 11.3% of their total income, in the form of compensation payments and an allowance of 308.5 CNY to purchase production equipment (e.g., mowing equipment), buy fodder and veterinary medicine, build storage rooms for hay or fodder, and so on. This can be seen by the decreased share of total income accounted for by animal husbandry, which decreased from 98.6% of the total to 70.1%, representing a decrease of 28.5% points. Laborers released from grazing work (an average of about 0.75 persons per household) could find off-farm jobs, so the share of off-farm income contributed by these jobs increased to about 10 times its original proportion (from 1.4% to 14.7% of total income).

Those who participated in both programs were mostly involved in cultivation activities, although their total income has increased by 32% since the implementation of the two programs; however, the proportion of total income contributed by farming and grazing of sheep decreased from 80.7% to 67.9% and from 19.3% to 13.1%, respectively, and compensation payments (16.5% of total income) and a production allowance (2.4% of total income) have become important and stable income sources for the farmers.

This analysis shows that the household income rose compared with their income before the programs. Especially for GPP households, the income (23 377 CNY) was higher than that of the average household (farmers and herders) in Xilingol (18 459 CNY; XLGLDRC 2011) because the compensation payment was higher and the grassland area was larger than was the case for households that participated in the SLCP or in both programs. In contrast, the annual incomes of households that participated in the SLCP (10 002 CNY) and in both programs (14 648 CNY) were both lower than the region's

Table 5. The relationship between the bid amount and the proportion of the households that were willing to accept (WTA) that amount for the conservation of grassland in Inner Mongolia.

Annual bid amount (CNY ha^{-1})	75	150	300	450	750	1050	1350	1500
Proportion of households willing to accept (%)	10.0	24.0	46.0	52.0	63.0	69.0	78.0	89.0

average. Although this is an imperfect comparison (i.e., the mean Xilingol income statistics available from the government include families that participated in the two PES programs), it was not possible to obtain separate income statistics for households that did not participate in either program.

Since the implementation of the programs, the grassland conditions have improved and net primary production increased by 20% (Yang 2007), which had positive effects for the households in terms of better grazing and farming conditions; in addition, the price of agricultural and livestock products has increased in recent years, therefore the income per household from farming and grazing has increased by about 1091, 2347, and 799 CNY, respectively, for households that participated in the SLCP, the GPP, and both programs. These amounts were less than the payments provided by the programs, which amounted to 1846, 2648, and 2424 CNY, respectively (table 4). Due to the restrictions on grazing and farming, some workers have been released from agricultural work and have moved to the cities to earn off-farm wages, especially for the SLCP and GPP households. The income increases from these off-farm jobs were 1985 and 3239 CNY, respectively, which were higher than the respective income increases from farming and grazing.

Unfortunately, the cost of living (the cost for food, medicine, clothing, and other domestic expenses, but excluding farming and animal costs) has also increased since implementation of the programs. Table 4 shows that the average annual cost of living for families that participated in the SLCP, the GPP, and both projects increased by 2446.3, 2970.2, and 2608.7 CNY per household, whereas their incomes increased by 6742.7, 9165.8, and 3556.5 CNY per household, respectively. Therefore, the net income has increased for all three household types.

4.2. Herder WTA

To calculate the expected household WTA for protecting the grasslands, we used multinomial logistic regression analysis, and the regression was both strong and significant ($F = 81.207$, $P = 0.002$, $R^2 = 0.931$). Based on the bid–response data (table 5), we plotted the graph shown in figure 2, which shows the relationship between the bid amount and the proportion of households who were willing to accept that amount (P), and the probability density as a function of the bid amount.

Figure 2 shows that the consensus rate increased steadily with increasing bid amount. Most of the farmers were willing to receive an amount between 450 and 645 CNY ha^{-1} annually (with a maximum probability density of nearly 9×10^{-3} for this range of values), and the average annual WTA per household was 625 CNY ha^{-1} (versus a current maximum

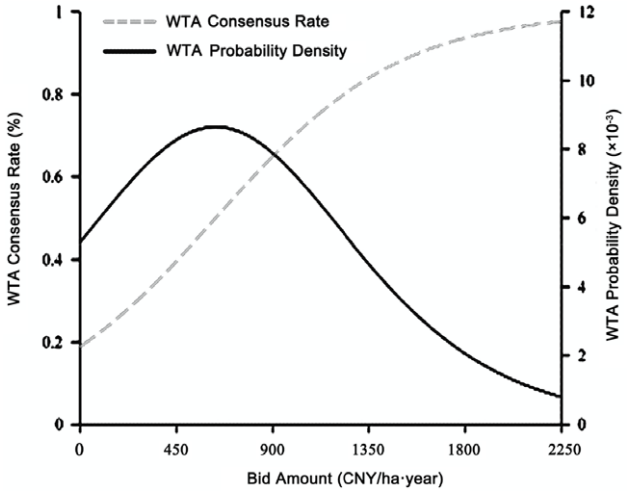

Figure 2. Functional relationships between the bid amount and the associated WTA consensus rate and probability density.

payment of about 270 CNY ha^{-1}). In the Xilingol League, the total area of grassland affected by grazing prohibition was 9.84×10^5 ha in 2012, thus the total WTA for the study area ranged between 443×10^6 and 635×10^6 CNY yr^{-1}. This result can be used as a reference value to design a PES scheme and determine the total funding required to promote conservation measures in Inner Mongolia's grasslands.

Most of the herders (about 86%) determined their WTA based on the economic loss that resulted from grazing prohibition and the average cost required to maintain their basic standard of living (e.g., the costs for food and fuel). About 78% of the herders would like to use the compensation provided for grassland protection to build fences to keep their animals in a field and to purchase fodder; about 25% would like to hire local herders to graze their animals in grasslands where grazing is still permitted and prevent animals from damaging the degrading grasslands, about 14% would purchase equipment needed to produce fodder (e.g., water tanks, fodder silos, grass mowers), and about 13% would like to invest in supporting tourism activities. We found the following additional information that provides insights into how to modify the PES schemes:

- Employment activities: About 82.5% of farmers had a high willingness to implement PES because they were aware of the benefits of the resulting environmental improvement, and the production and benefits from their small area of farmland were too little to sustain their livelihood. About 76.1% of the herders who performed off-farm work as migrant workers also had strong willingness to participate in PES, because by so doing, they could earn more income from their grasslands

that they no longer used for grazing due to a shortage of workers. This result is similar to what has been found previously in a forestry PES program, where the decreased reliance on forest resources and the high proportion of off-farm income (about 32%) led to high WTA (4950 CNY ha^{-1} annually) for forest protection (Li and Li 2010).

- Area of grassland: The total grassland area owned by a family significantly affected WTA. Among those who owned more than 200 ha of grassland, only 35.7% were willing to accept the payment scheme. However, those who owned less grassland were more interested in the payment scheme; for instance, 67.7% of those who owned less than 67 ha of grassland agreed to accept the payment scheme. This result suggests that the willingness to participate in the payment scheme was strongly determined by the herders' reliance on the grassland for grazing; those who owned the most grassland normally depended more on their livestock for their income and livelihood, and did not wish to reduce their number of animals. However, owners of a small area of land could normally choose either grazing or off-farm activities to supplement their income, and were therefore more willing to accept some payment to limit their grazing and to support other activities.
- Willingness of the herders to participate in conservation: Among those herders (89.7%) who were willing to participate in grassland conservation, 65.6% wanted to continue the PES scheme because they have realized the significance of grassland degradation and reduced production for grazing; for example, grassland productivity decreased from 2.26 kg ha^{-1} in 2000 to 1.39 kg ha^{-1} in 2007 in unprotected grassland in the study area (Yang 2007). The herders were willing to continue their participation because they could obtain subsidies from the government's PES program, and they could use this money to support their grassland protection activities, while also supporting their family despite the income loss caused by limited grazing.

4.3. Government WTP

We calculated the expected amount the government respondents were willing to pay to the herders to protect the grasslands (table 6) using logistic regression analysis, and the regression was both strong and significant ($F = 67.317$, $P = 0.003$, $R^2 = 0.943$). Figure 3 shows the relationship between the bid amount and the proportion of the officials who were willing to pay that amount (P_{WTP}), as well as the probability density for WTP.

Most of the officials were willing to pay between 375 and 600 CNY ha^{-1} annually, with a high probability density of nearly 9.6×10^{-3} for this range of values. The expected WTP can be estimated using equations (3) and (4), which predict an average annual WTP of 528 CNY ha^{-1}. The total area of grassland in which grazing is prohibited was 9.84×10^5 ha in 2012, thus the total payment would be between 369×10^6 and 590×10^6 CNY yr^{-1}. The current maximum payment standard is 270 CNY ha^{-1} annually, which is less than the WTP of the local governments but far below the herder WTA for conserving the grassland.

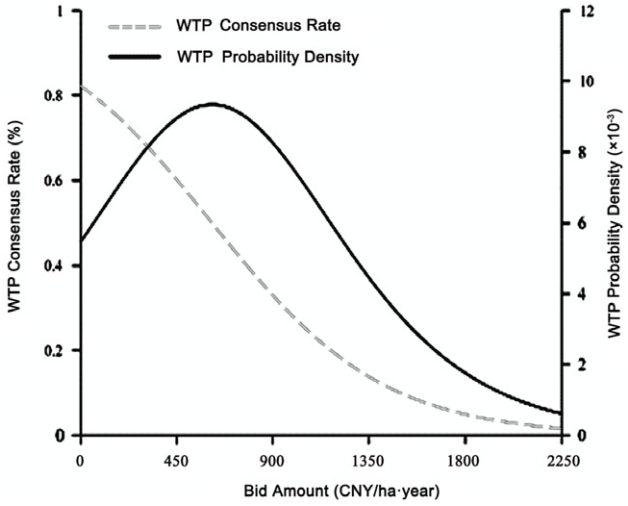

Figure 3. Functional relationships between the bid amount and the associated WTP consensus rate and probability density.

4.4. Stakeholder awareness and considerations for PES: herders versus officials

The herders and the representatives from relevant local government agencies told us about their awareness of the impact of the GPP and SLCP on the livelihood of herders, and this provided important background information for designing a locally acceptable and practical payment scheme that would fairly compensate the herders for their income losses caused by grassland conservation activities. The results (table 7) show that most of the respondents (56.4% of herders and 51.9% of officials) believe that the grassland conservation and restoration programs have affected the herders' livelihood by decreasing their net income and increasing the difficulty of their lives. Some (32.6% of herders and 25.9% of officials) nonetheless thought that the programs had a positive impact on the herders because of the improved grassland conditions and reduced sandstorm frequency compared to the time before the programs were implemented. However, the proportions who thought there was no impact from the programs differed between the two groups (11.0% of the herders and 22.2% of the officials), and the difference was marginally significant ($P = 0.0627$) because these officials thought the herders were adequately compensated for their losses and therefore were not forced to change their standard of living.

In general, the respondents welcomed the programs and considered them good because they received payments from the programs, because some of the workers released from the hard work of cultivation and grazing were able to earn wages from off-farm jobs in the cities (which also exposed them to new ideas from the outside world), and because the grassland conditions improved. They were also willing to participate in the program as long as the program payments continued, or if the program encouraged farmers to shift into activities that could provide income even if the program payments ended. All of the respondents were concerned about whether the programs would continue and for how long, and they noted that if the government ended the payments in the future, they would return to grazing in their grasslands. The other most important

Table 6. The relationship between the bid amount and the proportion of the government officials willing to pay that amount (P_{WTP}) for the conservation of grassland in Inner Mongolia.

Annual bid amount (CNY ha^{-1})	75	150	300	450	750	1050	1350	1500
P_{WTP} (%)	91.0	72.0	69.0	40.0	32.0	26.0	18	11.0

Table 7. Responses to questions designed to reveal the perceptions of payment for ecological services (PES): herders versus officials. (Note: Percentages represent the proportion of the respondents who agreed with the statement.)

PES perceptions	Herders (%)	Officials (%)	t-test (P level) for the difference
Impact of the Grazing Prohibition Project on herders' livelihood			
Loss	56.4	51.9	0.5627
Gain	32.6	25.9	0.1376
No impact	11.0	22.2	0.0627[a]
PES standard payment should be set based on:			
Income from grazing and farming	58.0	22.1	<0.001[c]
Loss from natural disasters	5.0	10.5	0.5307
Cost for environmental protection	10.0	17.4	0.2304
Cost for managing lands under the Grazing Prohibition Project and the Sloping Land Conversion Project	4.0	16.3	0.0019[b]
Living cost	13.6	23.3	0.1730
Other	6.4	10.5	0.3017
Source of PES funds			
Central government	62.6	56.6	0.1045
Provincial government	22.8	28.3	0.5114
County government	9.3	7.5	0.8663
Levies from herders	1.2	3.8	0.4528
Others (e.g., mining companies)	0.041	0.038	0.7226
Means of compensation			
Cash	74.2	62.8	0.0850[a]
Grain	10.0	12.3	0.8371
Employment opportunities and skills training	15.8	24.9	0.1815

[a] Significance level $P < 0.10$.
[b] Significance level $P < 0.01$.
[c] Significance level $P < 0.001$.

concerns were the growing conditions for grass (50% of the respondents), water availability (50%), vegetation cover (35.7%), and the number of animals they could own (10.7%). Some also raised concerns about grass species (7.1% of the respondents), biomass (3.6%), and soil conditions (3.6%).

The agricultural and pastoral families perceived the programs as affecting their livelihoods through a direct impact on their way of life, including by increased income from the program payments and wages, reduced grazing area (nearly half of the pastoral areas had grazing prohibited), the reduced number of animals (the number of goats was especially decreased, by 17.4%), the reduced percentage share of their total income from sheep (by 16.5%) and cattle (by 12.0%) for GPP families, and the 25.1% reduction in the proportion of total income from cultivation for SLCP families due to restrictions on grazing and cultivation (table 4), the increased cost for purchasing animal fodder and feed (from 8636 CNY in 1995 to 23 339 CNY in 2010), less dependence on bio-fuels (e.g., animal dung, dried grass, shrubs) but more dependence on coal, gas, and electricity, and increasing reliance on food imported from other regions.

Table 7 shows that most of the herders (58.0%) wanted to have the compensation amount calculated based on their general loss of income from grazing and farming, followed by compensation based on their cost of living (13.6%) and the cost of the grassland protection activities (10.0%). Although the government officials also prioritized the loss of income (22.1%) and cost of living (23.3%), they placed a much lower priority on income losses (by 36% points), and the difference was significant; they also placed a much higher priority on

the cost of environmental protection (17.4%), although the difference between the two groups was not significant. The government officials also placed a much higher importance on the cost of managing the GPP and SLCP lands (16.3%, which was 12% points higher than for the herders, and the difference was significant). These results suggest that the government officials considered the compensation from several angles, and tried to balance the economic and ecological aspects.

Table 7 shows considerable agreement between the two groups about who should pay for the programs. Most of the respondents (62.6% of herders and 56.6% of officials) believed that China's central government should pay the costs, and lower but similar proportions believed that the provincial government should pay (22.8 and 28.3%, respectively). Very few of the respondents (1.2% of herders and 3.8% of officials) believed that the herders should bear the cost. Table 7 also shows considerable agreement about the form of the payment. Most of the herders (74.2%) and most of the officials (62.8%) believed that the payments should be in cash. Relatively few (<13%) believed that payment in grain, as has been done under China's Grain for Green Program, was a good option. More government officials (24.9%) than herders (15.8%) considered that job and related training to increase employment opportunities was a good option, but the difference was not significant.

During the survey, both the households and the officials were able to choose their WTA or WTP according to their real willingness, because they have been involved in the program implementation for many years, have experienced the improvement of the grasslands, and want to have better grassland conditions. The households also realized their economic loss from limited grazing, and the amount they wanted to receive from the government (their WTA) was comparable to their loss from the limitations on their activities. This agrees with our findings in other studies (Li 2010, Zhen *et al* 2011), in which the WTA of farmers was determined by their direct income loss from decreased production. The WTP of officials was also based to at least some extent on the income loss of the households that resulted from grazing limitations. The households are receiving compensation from the government for their participation in the two programs, and they can use this amount to support their family, but workers released from working on the land could also find off-farm jobs in the nearby cities, which is becoming an important income source for the households.

The average household annual income in Xilingol was 5185.6 CNY in 1995, before the GPP and SLCP programs were implemented, but increased to 19 635 CNY in 2012, after the programs had been implemented. The SLCP group's income before the programs (3259.6 CNY) was lower than the regional average income level in Xilingol, but its income after the programs (10 002.3 CNY) was higher than the regional average because the decrease in the income from cultivation activities (mostly grains and potatoes) was much lower than the increase in the income from sheep and from the SLCP compensation payments, which amounted to 18.5% of total income (table 4). For the GPP group, average household income was 14 211.7 CNY before the program and 23 377.5 CNY after the program, and both were higher than the region's respective averages; this was because the GPP households depended on animal grazing for income, and this activity accounted for 98.6 and 70.1% of total income before and after the program, respectively. This difference is because the prices of meat, milk, and other animal products are much higher than those for the region's crops. For the households that participated in both programs, their average annual income was 11092.1 CNY (higher than the region's average) and 14 648.7 CNY (lower than the region's average) before and after the programs, respectively. The mixture of cultivation (mostly greenhouse vegetables with higher prices than grains) and grazing activities contributed to the income changes for these households.

China's PES schemes have brought mostly positive effects to the participants. A typical example that was reported recently (Zheng *et al* 2013) suggested that participation in a program to convert paddy land to dry land in Beijing, with the goal of improving the availability of water for other purposes and the quality of the available water, changed the distribution of household livelihoods and their production and consumption activities. Incomes doubled for both participants and non-participants, even though the income that participants earned from agriculture decreased, because they relied more on off-farm income. The income gap between participants and non-participants was 3554 CNY in favor of the participants, which was similar to the mean payment; this suggests that the payment standard was determined by the direct income loss from land conversion. The participants changed their production and consumption behaviors by increasing spending on production inputs, material assets, and education, which improved the livelihood effects of the program.

However, despite the overall promising results of our study, an alarming number of herders (88%) and farmers (90%) may return their retired land to grazing or farming activities if the program payments end. If the program encourages herders and farmers to shift into activities that can provide income even after the program payments end, there will likely be less pressure to return the retired land to grazing or cultivation. Because this is a common concern in other parts of the country (Uchida *et al* 2005, Zhen and Zhang 2011), governments must not end payments under these programs without providing participants with alternative ways to earn a living.

5. Conclusions

Our research combined government statistics with the results of interviews of households and government officials to quantify each household's WTA and the government officials' WTP for grassland conservation, and to reveal the factors that influenced these choices. We also analyzed the land-use and income changes that resulted from the government's PES projects. We obtained the following main conclusions from our analysis:

- Major PES projects implemented in the Xilingol League included the SLCP and the GPP. After implementation of these projects, the areas of cultivated land and grazing

land both decreased. As a result, herder income from cultivation and animal husbandry decreased, although income from sheep increased under the GPP because the high compensation payments allowed herders to purchase enough fodder to maintain large herds. In contrast, income from government compensation payments and off-farm activities increased, and became an important and stable income source for the herders.

- Most of the herders want to continue the PES projects to improve grassland conditions, and they were willing to accept PES to mitigate their economic losses. The average WTA of the herders was about 625 CNY ha^{-1}, which is much higher than the current maximum amount they receive (about 270 CNY ha^{-1}). On the other hand, government officials had a WTP of about 528 CNY ha^{-1} annually to the herders. Although this amount is much higher than the current annual payment of 270 CNY ha^{-1}, it is still less than the herder WTA. The gap between the herder WTA and government WTP is about 97 CNY ha^{-1}.

Hypothetical bias is likely to exist for the specific levels of WTA and WTP that we determined because the answers to our questions had no real consequences; respondents who stated that they would accept compensation for grazing restrictions or who stated that they would pay for grassland conservation were not required to actually do so. Some respondents may have stated that they would agree with some amount of money, but they could actually accept an amount less than their expressed WTA; similarly, some government officials may have stated that they would pay a certain amount, when, in fact, they would pay less (e.g., due to constraints on their budget) if placed in the real situation.

However, because the respondents were familiar with the subject of our questions after more than 10 years of involvement in the PES programs and because the hypothetical choices (bids) were based on our preliminary surveys, and thus closely mirrored the potential real choices for the residents of Inner Mongolia's grasslands, the results are likely to be realistic. Thus, the results of our study could reflect the gap between WTA and WTP to some extent. Perhaps most importantly, the WTA values were very similar to the economic losses of participants, which suggests that any hypothetical bias was relatively small. However, more research will be necessary to quantify the bias and its causes.

- The government officials considered the PES from both economic and ecological perspectives, whereas the herders emphasized their income losses and basic cost of living; thus, they related their compensation standard to their reliance on grasslands and their willingness to continue PES projects.
- Most of the herders and officials believed that China's central government and provinces should take responsibility for the compensation payments, and believed that the payments should be paid in cash rather than in grain or training to obtain skills that would enhance their off-farm income or permit additional farm activities such as the production of greenhouse vegetables. Our findings have significant implications for designing an operational PES scheme for our study area. The herders have clearly been experiencing economic losses from conservation activities, but although they wanted to participate in conservation activities, they also expected sufficient compensation payments to mitigate their losses. Unfortunately, they want more money than the government is willing to provide, and the gap between WTA and WTP, as well as the current very low payments, may lead some herders to expand grazing into restricted grassland or increase their number of animals. Our study confirms Bennett's (2008) results: some participants may resist the GPP and SLCP because they feel they are not compensated enough to participate, and will have no incentive to continue participating if the payments end. This potentially jeopardizes the success of the GPP and SLCP.

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