The Effects of Eco-Compensation in the Farming-Pastoral Transitional Zone of Inner Mongolia, China

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Abstract: Ecological compensation or eco-compensation has been implemented mainly through institutional arrangement in China. In the farming-pastoral transitional zone of Inner Mongolia, eco-compensation has been implemented in two modes, one for land use abandonment and the other for production-structure adjustment. Based on a detailed field survey, this study performs a comparative analysis of the willingness of households to accept economic compensation and consequently evaluates the effects of the two eco-compensation modes. The mode of eco-compensation for land use abandonment lacks a mechanism for generating employment opportunities and so is unsustainable. In contrast, eco-compensation for production-structure adjustment makes the pastoral and farming scales of households decrease significantly and most importantly helps to generate more job opportunities. Although this mode faces households with more market risk, it provides an effective means for resolving conflicts between ecosystems restoration and regional socio-economic development.

Key words: ecological compensation; ecologically fragile zone; willingness of acceptance; farming-pastoral transitional zone; Inner Mongolia

1 Introduction

In the past 50 years, the continual increase in human population and the consequently rapidly increased demand for food, water, timber, fuels and other resources have changed ecosystems significantly. As a result, two-thirds of ecosystem services across Earth have been damaged, resulting in negative impacts on humans, especially for those living in ecologically vulnerable regions (Millennium Ecosystem Assessment 2007). Regional socio-economic development at a relatively low level normally exhibits an inverse relationship with environmental condition, particularly in ecologically fragile regions (Zhao et al. 1999; Zhang 2006; Pagiola et al. 2008). In many parts of China where the economy has been lagging and ecosystems are very fragile, ecosystems have degraded rapidly in recent decades (Liu et al. 2005). Ecological compensation or eco-compensation is an important means of providing economic compensation to ecologically fragile areas so as to change land use practice and make local socio-economic development sustainable. This form of compensation has received more and more attention in recent years (Bennett 2009).

Initially, payment for ecosystem services (PES) was defined as a type of voluntary transaction of well defined ecosystem service(s) trading between provider(s) and buyer(s) (Wunder 2007). In this sense, it can be regarded as an alternative to command-control approaches, and some indirect approaches such as integrated conservation and development projects (ICDPs) have been deployed for sustainable management of natural resources in both developed and developing countries and regions (Jeanneret et al. 2003; Li et al. 2007; Baylis et al. 2008; Claassen et al. 2008; Pagiola et al. 2008; Corbera et al. 2009; Petheram et al., 2010). In China, however, eco-compensation has been implemented largely by local and national governments through institutional arrangement, aiming at adjusting the relationship among stakeholders. The core of the approach is to internalize external costs whereby individuals, companies, organizations or governments make payment for specific ecological functions or ecological services (Task Force on Eco-Compensation...
Mechanisms and Policies 2007). Practically speaking, eco-compensation is a means by which economic compensation is provided to those individuals or groups whose primary agricultural productivity for living has made ecosystems degrade significantly and urgent action is needed. The main purpose of implementing eco-compensation policies is to improve ecological environment by redesigning regional social and economic structures so as to make ecosystem services sustainable. Currently, eco-compensation policies implemented in China in the form of providing economic subsidies to households have been carried out through many ecological restoration projects, such as the Wetland Restoration project, Grain for Green project, Harnessing the Source Areas of Sand-dusts to Beijing and Tianjin project and the Preservation of Natural Forests project. The implementation of these large-scale projects has so far relieved the deterioration of ecological systems to a considerable degree, but at the same time exposed problems that need to be solved urgently.

First, the cost-benefit of households who participate in eco-compensation projects and their willingness to accept eco-compensation have been the subject of few studies in China. So far eco-compensation projects implemented in China have been designed largely in a top-down form and cover only specific areas. In the implementation of these projects, the national government provides payment directly to households for their abandonment of cultivated land so as to restore natural ecosystems, while local governments take a campaign-style mobilization to organize households (Bennett 2008). Due to the lack of sufficient financial support, conflicts arise between standard of eco-compensation provided by the national government and the size of the area covered by an eco-compensation project. To use available financial support in the most effective way requires an in-depth understanding of the willingness of households for eco-compensation.

Second, eco-compensation results in considerable socio-economic problems in some areas. Although PES programs are not designed purely for poverty reduction, they can produce significant synergistic effects. However, possible adverse effects can occur where property rights are insecure or if PES programs encourage less labor-intensive practices (Pagiola et al. 2008). Based on field surveys in Huize county of Yunnan province and Qingzhenshi County of Guizhou Province, Zhi et al. (2004) found that compensation policies implemented in these areas have significant positive impacts on the income of rural households, but at the same time made them dependent on the subsidy. The most essential factor for households to participate in an eco-compensation project is the economic benefit because they face the risk of lowering living standard after the abandonment of their cropland (Ke 2007). In other words, it is the economic benefit that affects farming and pastoral households’ decisions on participating in an eco-compensation project.

To address these problems, PES needs to be built up with other programs such as ICDPs, as hybrid schemes (Petheram et al. 2010). By doing so, the dual goals of environment conservation and poverty alleviation can be achieved. A hybrid use of subsidies for EBP (ecological restoring projects) with other rural and agricultural funding sources has been promoted in China for carrying out local eco-compensation programs (Gauvin et al. 2009; Li et al. 2009; PRC State Council 2000, 2002a, 2002b, 2007). Nevertheless, there is a high degree of variation in the local implementation of eco-compensation projects in China (Bennett 2009). Local eco-compensation projects normally fall into two modes of eco-compensation: one provides subsidies for land input to EBP, while the other provides developmental capital (like most ICDPs). To understand this variety and the corresponding effectiveness of eco-compensation measures, this study makes a detailed analysis of eco-compensation modes implemented in Xilinguole League, Inner Mongolia, China based on a field survey, and then evaluates the effectiveness of the modes for ecosystem restoration in this ecologically fragile area.

2 Study area
2.1 Eco-environment and socio-economic development
Xilinguole League is located in the middle and eastern part of Inner Mongolia Autonomous Administrative Region, China (Fig. 1). The shortest distance from the boundary to Beijing is 180 km. Under the effect of natural factors, such as geomorphic, soil, climate and vegetation, land use in the area is mainly in the forms of agricultural cultivation and/or pastoralization, a typical area where farming and pastoral activities are constantly transitional (Gao 2009). It is a typical northern semi-arid and sub-humid fragile eco-environment in China where land desertification and degradation are widespread.

According to the Inner Mongolian Statistical Yearbook (2008), Gross National Product (GNP) in the study area in 2007 was USD 4194.93 million, among which the gross value of agricultural product and GNP per capital were USD 566.67 million and USD 4125.62, respectively. Meanwhile, the annual net income per capita of rural households was USD 587.12, while the annual disposable income per capita of urban households reached USD 1496.38. In the GNP, the percentage of primary, secondary and tertiary industries was 13.51%, 58.81% and 27.68% respectively, and used 52.23%, 12.13% and 35.63% of total laborers. For most farming and pastoral households, nevertheless, production from farming and pasture is the main income source.

2.2 Factors impacting regional ecosystems
Eco-environmental fragility is normally the result of large scale socio-economic development of human beings and
severe natural disasters, which break the man-land balance (Barrow 1991). The fragility of the eco-environment in the study area is the result of frequent natural disasters, typically dust storms and severe land degradation. Using the U. S. National Oceanic and Atmospheric Administration (NOAA)’s Advanced Very High Resolution Radiometer (AVHRR) data to extract dust storm information and then verify with meteorological data, it was found that the degree of land cover and vegetation cover has a close relationship with the form and intensity of dust storms in the area (Fan et al. 2002).

Measures to reduce dust storm disasters are to eliminate the impacts of land and ecological degradation, mainly caused by humans’ unreasonable methods of land use (Fan et al. 2002). Over a long historical period, land use in this area was nomadic herding and achieved a kind of sustainable maintenance of the eco-environment in ancient times but was broken during the metaphase of the Qing Dynasty. In the 20th century several large-scale climaxes of human migration and wasteland reclamation took place and cultivated land area extended very quickly while meadow area declined. As a result land desertification and grassland degradation rapidly increased and the whole prairie eco-environment experienced unprecedented damage because of population, economic profits and government decision-making (Bayaer et al. 2005). Although during the latest 40 years the zonal boundary of grassland distribution in Xilinguole League has varied frequently, it has shown a tendency to move eastward. This has resulted in a 14% decline in meadow steppe and a 12% decline in dry steppe. Areas of desert steppe and desertification steppe have increased by 11% and 100% respectively and these rates of change have been accelerating (Liu 2003; Cao et al. 2006).

Fig. 2 shows the changes of key indices reflecting regional farming and pastoral scales between 1987 and 1999. In the figure, the sown area of farm crops is taken as the index of farming scale, while the total livestock carriage as the index of animal husbandry. During this period agriculture has been scaled up and farming areas increased from 172 000 ha at least to 236 000 ha at most. Total livestock carriage increased from 11.92 million sheep unit to 16.83 million sheep unit, an increase of 1.4 times. This change in agriculture imposes great pressure on local eco-environments and causes grassland and ecosystems to degrade.

The implementation of a contract-based land allocation system in China in the early 1980s provided an external policy for farming and pastoral households in the area to develop family economy from grassland. Under the drive of self-interests on economic development and increases in income, the farming and pastoral households have overused the productive functions of the grassland. As a result large-scale damage to grasslands has occurred, and significantly affected ecological services (Wang 2007).
improve the increasingly deteriorating eco-environment, a program named “Enclosing and Transferring (EAT)” has been carried out in Xilinguole League since 2001.

EAT aims at identifying socio-economical factors resulting in eco-environmental deterioration, and consequently realizing management over a land of more than 13 million ha, nearly 80% of the study area, by means of suspending grazing in spring, breeding in cowsheds instead of grazing, rotating grazing in divided regions, conserving water resources, and realizing grain for green and ecological migration (Liu 2002). Capital for compensating households during the implementation of EAT comes from many regional- and national-scale projects, including the projects of Harnessing the Sources of Sand Dusts to Beijing and Tianjin, Ecological Migration, Drinking Water Protection, Disaster Prevention, Integrated Agricultural Development, and Poverty Reduction.

Besides providing a direct subsidy to households for abandoning cultivation, this means has also been implemented in some areas by providing special support to households to change their farming and pastoral production structure and shift labor from rural areas to cities, as well as from the primary industry to the secondary and tertiary industries. These multiplex forms of eco-compensation can be categorized into two modes. The primary mode is in the form of providing a subsidy to households directly in terms the area of their contracted land. This subsidy is normally made by the national government according to standards of the implemented eco-compensation projects. The other mode integrates capital from multiple sources, makes households adjust their production structure and encourages the transfer of population and laborers from traditional agriculture to cities and secondary and tertiary industries. Under this mode local governments normally develop favorable policies, including providing favorable loans to households willing to move to some villages close to cities and predominately involved in breeding dairy cows or planting vegetables for satisfying the growing demand for these products across China. In some areas, free professional training for those who migrate to cities and engage in secondary and tertiary industries, a reduction or even full exemption of some kinds of tax, and provision of a subsidy for child education are also offered. We will refer to these villages as simply dairy villages and vegetable-planting villages hereafter.

The mode of land compensation is mainly implemented in the Grain for Green project where grazing in spring is suspended and breeding in cowsheds encouraged. However, there is a difference in agricultural production form between farming households and pastoral households and a disparity in the types of land resources and methods of ecological compensation. Farming households’ contracted land is mainly cropland and production is mainly crops. The area of the cropland contracted to each household is very small and the eco-compensation came mostly from the Grain for Green project. During the initial period of the project, the standard subsidy was USD 347.83 ha$^{-1}$, and during the second period, extending from the end of the initial period the standard became USD195.65 ha$^{-1}$. Each period lasts five years for economic forest and eight years for ecological forest. Most land contracted to pastoral households is grassland, with a small quantity of cropland to plant silage such as silage corn. The standard of eco-compensation for suspending grazing was USD 1.33 ha$^{-1}$ and for prohibiting grazing USD 10.76 ha$^{-1}$.

The mode of eco-compensation for production-structure adjustment has been carried out largely by local governments which make use of local socio-economic and natural resources to build up special near-city villages that plant vegetable or breed dairy cows in order to satisfy the demands of fast urban development. This makes farming and pastoral households transit from traditional agriculture to more modern forms. Capital for supporting local households to make production adjustment comes from many resources including projects such as Ecological Mitigation, and New Energy Construction in Rural Areas. Those who moved to the newly developed vegetable-planting villages or dairy villages can enjoy not only a land allowance but also a subsidy for carrying out new production and living allowance. However, each household needs to pay USD 724.64 to local governments, and in return receives a 3-bedroom apartment and 0.2 ha of vegetable field (including 0.033 ha of vegetable greenhouse) in vegetable-planting villages or a 3-bedroom apartment and a cattle shed in dairy villages, the construction cost of which is USD 4347.83. This means that each household received a subsidy of USD 3623.19.

### 3 Data

To evaluate the effectiveness of eco-compensation implemented in the study area, we carried out a comprehensive field survey from 19–29 October 2008, when most people in this area were free from agriculture and pastoral duties and available to accept our survey.

Before the field survey we obtained detailed information from three sources in order to gain a better understanding of the eco-environment: (i) official statistics from the Inner Mongolian Statistical Yearbook (1989–2008); (ii) land use/land cover data in 2000 from the Data Center for Resources and Environmental Science of the Chinese Academy of Sciences; and (iii) desert data in the 1990s from the Data Center for Environmental and Ecological Science of West China. To process and integrate the land use/land cover data and the desert data we used ARC GIS Desktop 9.3. Our field survey was carried out mainly in Zhengxiangbai Flag and Xianghuang Flag, a typical transitional zone between agricultural and pastoral
Detailed survey sites are shown in Fig. 3. Most of these sites are mainly at the fringe of deserts, while two dairy villages and a vegetable-planting village surveyed are near cities or towns. This survey obtained information mainly at household and individual levels. Both pastoral and farming households were surveyed and then divided according to the two eco-compensation modes mentioned earlier. Through this survey, we obtained 240 valid questionnaires, among which 73 were from farming households and 167 from pastoral households. Amongst questionnaires from farming households 15.1% were from households in a vegetable-planting village, covering nearly 40% of the total households in the village. Amongst the questionnaires from pastoral households 23.4% were from households in dairy villages.

The content of this survey includes two major parts: each household’s basic living information and effects of eco-compensation projects. The former part includes each household member’s age, education level and employment status, in addition to the income, expenditure, land resources and products of the household. The latter part covers each respondent’s cognition about eco-compensation and grassland ecosystem’s functions and changes, attitudes towards eco-compensation policies and willingness to accept eco-compensation. All collected data was organized with SPSS v17 (SPSS Inc., Chicago, USA).

4 Results and analysis

4.1 Changes in the production structure of households

The majority of respondent households felt that their production behaviors have changed. However, changes in households’ production behaviors differ under different eco-compensation modes. In vegetable-growing villages 18.2% of households felt no change in their family production, while this figure becomes 16.4% in dairy villages.

For normal farming and pastoral households in the study area, change in production behavior is reflected by an increase in the number of off-farm work and livestock and yet a reduction in cultivation. A total of 24.2% of farming households and 14.8% of pastoral households showed an increase in off-farm employment, while 24.3% of farming households indicated that the area of their arable land was reduced because of cultivation abandonment. In the change of livestock, the number of households whose livestock increased is larger than that whose livestock decreased, with 9.7% against 4.8% for farming households and 26.6% against 22.7% for pastoral households. There were 30.6% of farming households and 18.8% of pastoral households who felt no change. These results demonstrate that the eco-compensation mode based on household’s production adjustment implemented in vegetable-planting and dairy villages has exerted a significant influence. It has made a large number of households in these villages increase the scale at which they plant vegetables and economic crops and breed dairy cows so as to increase their income.

In animal husbandry, livestock-breeding measures have changed dramatically after grazing programs aiming at suspending and prohibiting grazing were carried out in this area. In 1997, grazing was almost the only means to raise sheep and cows in the survey area, but in 2007 most of the households took a mixed way of grazing animals in summer and autumn and breeding them in cattle sheds in winter and spring. As dairy cows need to be looked after carefully and bred together, most of them are bred in cattle

<table>
<thead>
<tr>
<th></th>
<th>Dairy households</th>
<th>Normal pastoral households</th>
<th>Vegetable-planting households</th>
<th>Normal farming households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep (Head)</td>
<td>110.64</td>
<td>10.13</td>
<td>-100.51</td>
<td>348.18</td>
</tr>
<tr>
<td>Beef Cow (Head)</td>
<td>5.97</td>
<td>0.08</td>
<td>-5.88</td>
<td>29.03</td>
</tr>
<tr>
<td>Dairy Cow Head</td>
<td>5.26</td>
<td>5.26</td>
<td>0.18</td>
<td>0.69</td>
</tr>
<tr>
<td>Horse (Head)</td>
<td>0.28</td>
<td>0.28</td>
<td>2.92</td>
<td>0.39</td>
</tr>
<tr>
<td>Total (Sheep Unit*)</td>
<td>140.51</td>
<td>38.21</td>
<td>-102.31</td>
<td>508.82</td>
</tr>
</tbody>
</table>

* The conversion is according to Xilinguole League Grass-Husbandry Balance Implementation Regulations (Interim) (2004), in which an adult sheep or goat equals 1 sheep unit and a big cattle (including horse, cow and more) equals 5 sheep unit.
sheds only. As shown in Table 1, after the implementation of eco-compensation project, the total quantity of livestock in the dairy village became 38.21 sheep unit, 102.31 less than before. In vegetable-planting villages it became 2.91 sheep unit, 4.45 less than before. In contrast, the total quantity of livestock of normal pastoral households become 460.9 sheep unit, 47.92 less than before and that of farmer’s became 5.02 sheep unit, 0.62 more than before. Comparatively speaking, the total quantity of livestock of normal pastoral households reduced only by 47.92 sheep units, while normal farming households increased 0.65 sheep unit. This significant decrease in the total cattle carriage of the farming and pastoral households living in vegetable and dairy villages is of considerable help for alleviating potential pressure of grazing on the eco-environment of the grassland and generates more ecological benefits.

4.2 Labor structure and allocation

As shown in Fig. 4 there are two characteristics exhibited in the structure of farming and pastoral laborers. In groups where all household members are under 56, the percentage of farming laborers decreases at younger ages, but the percentage of off-farm laborers is increasing. In respondents where all household members are 16–25 years old, the percentage of farming laborers is less than 45%. This trend means that the people are inclined to do off-farm jobs at younger ages because once older, their competitive capability for off-farm work is weakened. In addition, it can be noted that it normally takes around 25 years for the farming and pastoral laborers with an age of 16–35 to become a principal part of social laborers, while those with an age of above 35 to retire.

The structure of the labor force is also affected by eco-compensation modes and productive features. Vegetable planting is a high labor-intensive agriculture and has apparent economic efficiency, so it absorbs plenty of the agricultural workforce. As a result, in vegetable-planting villages laborers older than 26 years are totally engaged in crop-plantation. In dairy villages there are still a large number of laborers who are older than 26 and undertaking off-farm work. This can be attributed to the fact that the dairy villages are largely distributed near cities where laborers have more opportunities for gaining off-farm jobs.

4.3 Income of households

We added up income from all sources for each household including from off-farm work and selling vegetables, crops and animals, as well as from eco-compensation subsidies, social security, transferability and property. As a result, we obtained the structure of the main income for each household as shown in Fig. 5. We found significant differences in the income structure of farming and pastoral households. However, the effects of different eco-compensation modes on the income of households are related to specific eco-compensation projects.

The income from eco-compensation for a household in a dairy village was USD 527.18, while the income of a normal pastoral household was USD 374.49. However, the income in the vegetable-planting village was USD 180.66, which differs slightly with the income of a normal farming household (USD 182.91). The total income from the family business and salary in the dairy village is USD 2896.71, while a normal pastoral household has an income of USD 3443.53. This is in contrast to the income of households in the vegetable-planting village and of normal farming households, which is only USD 1743.21 and USD 927.61, separately. On the whole, the average income of
pastoral households obtained from eco-compensation is twice that of farmers, while the average income of pastoral households gained from business and salary is almost two to four times the income of farming households. Hence, the farming household family economy is more fragile.

Farming and pastoral households have a different preference on eco-compensation modes. On the condition that there is little difference in the income from eco-compensation between a household in a vegetable-planting village and a normal farming household, the income of the former is larger and has less dependence on eco-compensation. Similarly, a pastoral household enjoys a high income from trading livestock, and its income from eco-compensation has less impact on its daily life and production than a farming household. However, a dairy household’s income from markets is lower than a normal pastoral household.

The income of a household in a dairy village relates to the household’s business status. First, it takes a long period from buying a dairy cow to receiving an income from it and requires a large primary input. Some households have not reached the payback period, so it is normal that they have low revenue at this stage. Statistics shows that in the dairy village 13.7% of the households said that their net income from breeding dairy cows was zero or even negative, among which, 40% of them brought up more than 10 heads of dairy cows. A quarter (25.6%) of households said their net income per head of dairy cows was less than USD 290. In the two groups, 60% of the households raised more than five cattle, while 40% of them raised no less than 10 cattle.

Second, there are other factors which also impact the revenue from breeding dairy cows, such as the number of dairy cow raisers, the cost for raising up fodder and forage and for milk acquisition, the breeding scale and stability, and techniques. Due to these factors, dairy households are still constrained from significantly increasing their income.

Besides the difference in income structure and quantity, the production objective of a pastoral household differs under different compensation modes. The objective of a dairy village is to realize modern animal husbandry, which is market-oriented and needs intensive management. Household product in a dairy village is mainly milk, which is a highly marketized commodity. Among respondent households in the dairy village, more than 97.4% of them sell more than 90% of their milk product in markets, and 89.7% of them even sell almost all of their milk in markets. In normal pastoral households, the main products are beef and mutton. It is shown in the survey that mutton has a larger proportion for sale than beef. In a normal pastoral village, more than 86% of households sell more than 90% of their mutton and 21.3% of them sell almost all of the mutton they have. In contrast, only 55.89% of them sell more than 90% of their beef and only 27.94% of them sell almost all of their beef. As a result, the livestock products of a dairy household have a higher ratio of value conversion, which is convenient and helpful for increasing household income. However, they are also facing potential market risks, because changes in income vary with the supply-demand relationship driven by markets.

4.4 Willingness of households on accepting eco-compensation

Through performing a statistical analysis of the surveyed results on farming and pastoral households’ willingness to accept eco-compensation, we found that households’ enthusiasm for participating in an eco-compensation project is relevant to whether they are able to gain sufficient economical benefits from the project. This is reflected in three aspects.

First, the Grain for Green project and the project for Restoring Ecological Forest provide a household with a subsidy higher than the compensation from the program for prohibiting and suspending grazing. This has resulted in a different household enthusiasm to participate in the projects. When answering the question “whether necessary to continue the ecological restoring projects of the Grain for Green and the suspension and prohibition of grazing”, in a dairy village and a normal pastoral village, the households that chose yes were 61.5% and 61.7%, while in a vegetable-planting village and a normal farming village these households comprised 81.8% and 79% respectively.

Second, the standards of eco-compensation that the farming and pastoral households are willing to accept are close to or a little higher than the current standards provided in eco-compensation projects. In the survey area, households who take part in the Grain for Green project need to plant trees in a barren or hilly land that has the same size as the cropland previously cultivated by them. Because many local households regard some barren land also as their contracted land, they feel that the compensation standard is USD 173.92 ha⁻¹, although the standard of the compensation paid by the state is USD 347.83 ha⁻¹. An analysis on the acceptable standard from all 71 valid responses shows that for respective standards of USD 434.78 ha⁻¹, USD 347.83 ha⁻¹, USD 217.39 ha⁻¹ and USD 173.92 ha⁻¹, the percentage of respondent households who are willing to accept the standards is respectively 38%, 5.6%, 11.3% and 19.7%, accounting for 74.6% of the whole (Fig. 6). A survey on an average standard in different groups was also conducted. Among the three groups, namely households in a vegetable-planting village, normal farming households and normal pastoral households, it was found that the average standard was USD 362.7, USD 323.13 and USD 387.39 ha⁻¹ respectively. It is interesting to note that the averages of their willingness are very close to each other, although the expected standards of individual households differ.
Finally, a household’s willingness to accept eco-compensation is closely related to its economic interests and if its expected interests cannot be satisfied, it has less enthusiasm for accepting eco-compensation or even for taking part in an eco-compensation project. In our questionnaire, when asked if the subsidy’s standard in the following term was to become half of the current standard would they still like to take part in the eco-compensation project, most of the households selected “no”.

5 Discussion

In the study area, local eco-environments have been degraded considerably because of disturbances from human activities (Fan et al. 2002, 2007; Liu 2003; Bayaer et al. 2005; Cao et al. 2006). Indeed, the growing population and the need for increasing family income have led to a significant increase in farming and pastoral scales, which expanded 1.4 times from 1987 to 1999. Therefore, the main objective of eco-compensation implemented in the study area is to reduce the pressure of human demands on the eco-environment through changing the income structure of households (Liu 2002).

PES (payment for ecological services) programs are often designed on the assumption that households can find alternative income sources (Uchida et al. 2007). In China, with high speed development in the socio-economy, more and more people gain opportunity to obtain off-farm employment. As shown in Fig. 7, laborers in the primary industry of the study area have decreased dramatically from a maximum of 368.7 million to 306.5 million from 1997 to 2008, and their proportion in the total population also dropped from a maximum of 50.1% to 39.6% during the period. This is due to either a gradual reduction in the growth rate of population or an increase in alternative income sources or both.

A positive effect on transferring agricultural and pastoral laborers to off-farm work has been found in the implementation of the Grain for Green project (Uchida et al. 2009). Earlier in this study, our field survey results show that among the surveyed households, there are as many as 24.2%, 17.9% and 14.8% of normal farming households, dairy households, and normal pastoral households who have witnessed the liberation of a considerable number of laborers from agricultural and pastoral sectors. However, people in different age groups have different opportunities to obtain off-farm work. The descending trend of laborers to obtain off-farm jobs as their age increases is because the older laborers generally lack competitive capacity and also are less willing to move to new places than younger ones. If no additional policies are made, it may take at least 25 years for most of the laborers to transfer from traditional agricultural or pastoral production to modern industrial sectors. This may be a general tendency in ecologically fragile areas because a similar phenomenon has also been observed in the Poyang Lake area when eco-compensation was implemented (Wang et al. 2010). However, this labor-transferring process is too slow and additional mechanisms are needed in order to accelerate the process.

Transformation of rural laborers can significantly benefit both local households and regional eco-environments. Based on field survey results and data collected, a comprehensive study on the benefits of the project on Harnessing the Sources of Sand Dusts to Beijing and Tianjin showed that the project has helped to improve the function of local ecosystem services significantly. In such an ecologically fragile area the implementation of the eco-compensation project has played a very important role in promoting long time development of the regional society and economy (Gao et al. 2008). However, through our comparative analysis we found that the production restructure mode can achieve much better effects. It is shown in the detailed survey results that households in vegetable-planting and dairy villages gain more capital income than normal farming or pastoral households on average. Furthermore, the number of animals a dairy pastoral household can have, calculated in sheep units, is much less than a normal pastoral household and the area of land cultivated by a household in a vegetable-planting village is less than that by a normal farming household.

The functional change of land use resulting from the implementation of eco-compensation affects the income of farmers considerably (Li et al. 2009). However, there are still two major problems that need to be resolved. The first is the duration of eco-compensation projects. It has
been found that households in the study area have been pursuing compensation at a level comparable with their loss from the abandoned land. Being aware of the problem, both national and local governments have recently made policy changes to the Grain for Green and the Grazing Prohibition projects. These include the decision to extend the subsidy for households for an additional term in the implementation of the Grain for Green project, and the establishment of compensation and rewarding mechanisms to protect the grassland. However, the level of subsidy in the Grain for Green project has been lowered in the new term and sufficient capital has not been provided in both projects to help local governments to establish eco-compensation mechanisms for generating more off-farm employment.

Through restructuring the production-structure of households, we found that it may take 25 years at least for rural laborers who abandoned land due to the demand of ecological restoration to gain a full transformation from traditional agricultural activities. This can reduce pressure on the already fragile land to a very significant degree. As detailed by Han et al. (2010) and earlier in this study, this is also achievable through long term eco-compensation mechanisms, such as building up special vegetable-planting and dairy villages.

The second problem is that most of rural households lack experience when undertaking modern agriculture and facing with market risks, especially pastoral households. Hence, not only capital, but also advanced knowledge and skills for business management and use of advanced techniques, should be provided to help these households. This is a very common and urgent problem that needs to be solved with an effective mechanism, since many similar cases have been found in other ecologically fragile areas. Typical cases are the middle reach of the Yangtze River and Sichuan province where the Wetland Restoration project and the Grain for Green project have also been implemented (Zhou et al. 2002; Yang 2007).

6 Conclusions

In order to achieve eco-environmentally friendly sustainable socio-economic development, several eco-compensation projects have been implemented in the farming-pastoral transitional zone of Inner Mongolia since 2002. This yields two modes of eco-compensation, both of which improve local eco-environmental and socio-economic conditions. However, some apparent differences have also become clear during the implementation process. Although it has been widely implemented in China, the mode of eco-compensation for land use abandonment is unsustainable because it lacks a mechanism for generating employment opportunities. Although a certain number of laborers can obtain off-farm jobs and consequently abandon some arable land, there are more households who tend to increase than decrease their livestock in order to increase their income. This may result in an increase in pressure on the eco-environment. Due to the slow process of labor transformation, this mode needs to be implemented for a long time in order to improve regional ecosystems in a sustainable form.

In contrast to the mode of eco-compensation for land use abandonment, the mode of eco-compensation for production-structure adjustment has been implemented by setting up a number of specific villages to plant vegetables or to breed dairy cows so as to satisfy the fast growing demands on milk products and vegetables of nearby cities. Products in these special villages can be transported immediately to markets and the income of the households gains a significant increase. Most importantly, this mode alleviates the carrying capacity of livestock in the study area significantly, and encourages agricultural and pastoral laborers to shift to secondary and tertiary industries.

Although the mode of eco-compensation for production-structure adjustment has many advantages over the mode of eco-compensation for land use abandonment, typically because it is able to generate more employment opportunities, it has been implemented in a very limited number of villages and largely financed by local governments. In addition, there are also some risks in the processes of production and sale of products to markets. Furthermore, these villages are at an early stage of development and lack not only capital and techniques but also vision, skills and experience. These limitations have made it very difficult for households to cope with risks arising from violated markets. To minimize risk, it is necessary to enhance the capabilities of households for coping with market risks, such as providing training and insurance, setting up a warning system and more. Despite these difficulties, the practice in the study area demonstrates that the mode of eco-compensation for production structure adjustment can be implemented effectively when sufficient support is provided by all levels of government.

References


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