Review

Research Progress on the Theory and Practice of Grassland Eco-Compensation in China

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Abstract: In order to curb the phenomenon of grassland degradation caused by human activity, China has begun the exploration of grassland eco-compensation, setting an example for the ecological protection of grasslands and sustainable use of resources around the world. At this stage, China has invested more than 170 billion yuan in grassland eco-compensation, benefiting 12 million farmer and herder households. The related research involves various perspectives, scopes, and methods, but lacks systematic reviewing. This study reviews the relevant theoretical and practical research and explores the connotations and effects of grassland eco-compensation in China. In general, the current grassland eco-compensation in China is a large-scale ecological-economic institutional arrangement with the following five characteristics: (1) the goals are to maintain the grassland ecosystem services and increase the income of herder households; (2) the main bodies are governments and herder households; (3) the main method is financial transfer payments; (4) the compensation standards are based on the opportunity costs of the herder households' responses as the lower limits and the grassland ecosystem service values as the upper limits; and (5) it is a comprehensive compensation system that requires legal, regulatory, technological support and long-term mechanisms. Since 2011, driven by the grassland eco-compensation policy, the income levels of herder households in each pilot area have generally increased, and the overall ecology of grasslands has slightly improved. However, there are still some areas where overload is common. Additionally, there are regional differences in the satisfaction degree of herder households, which is mainly affected by factors such as family income, compensation cognition and family holding grassland scale. Our analysis shows that the shortcomings of current theoretical research are mainly reflected in the low precision of scientific compensation standards, the lack of a basis for differentiated standards, and the single compensation method. The shortcoming of practical research is that most effect evaluations cannot reflect the role of eco-compensation in it. This study suggests that future work should focus on the response mechanism of herder households and the improvement of the compensation measures. At the same time, the scope of research should be expanded, and we should learn from advanced compensation experience in other fields.

Keywords: payment for ecosystem services; grassland eco-compensation; eco-compensation policies in China

1. Introduction

With the deterioration of the natural ecosystem and the development of research on ecosystem services, humans have gradually realized the important economic value of the ecosystem services [1]. However, in the interaction between humans and nature, human activities often lead to external effects on others [2]. For example, planting trees, watershed management and soil remediation always produce positive externalities. Overgrazing, excessive fertilization and untreated sewage discharge always produce negative externalities [3,4]. Without intervention, the protectors often terminate the protective behaviors,

because it is difficult to obtain benefits from the positive externalities. Meanwhile, destroyers benefit from not being punished by negative externalities, and thus tend to keep destroying. For a long time, this lack of ecological justice has ultimately led to the overuse of resources, which harms the interests of all [5]. In order to achieve sustainable supplies of ecosystem services and internalize the externalities of the ecosystem services, many countries have begun to explore eco-compensation [4].

In the second half of the 20th century, the concept of sustainable development gradually reached a consensus in the international community. Some developed countries have taken the lead in the exploration and practice of eco-compensation. Internationally, a concept similar to eco-compensation is "payment for ecosystem services (PES)". PES was first widely practiced in forest vegetation restoration, and related research includes a legal framework [6], transaction costs [7], case analysis [8] and so on. While it has produced some eco-economic benefits in forestry systems, PES has gradually been introduced into more and more other ecological conservation fields [9–12].

Eco-compensation research in China started relatively late. However, under the national conditions of promoting the construction of ecological civilization, the Chinese government attaches great importance to improving the eco-compensation mechanisms. At present, China has formed an overall layout of eco-compensation that is dominated by the government, with central financial transfer payments as the main source of funds, and governments at all levels as the main body of implementation [13]. Additionally, it has achieved remarkable results in various ecosystems [14–16], ecological function areas [17], resource extraction areas [18] and agricultural planting areas [19,20].

As the world's largest terrestrial ecosystem, grasslands account for about 37% of the world's non-glacial area [21] and 30–40% of China's land area [22], and have important ecological functions [23]. In recent years, grassland degradation has been widespread in many countries [24–26], posing huge challenges to the sustainable provision of grassland ecosystem services [27–29]. However, compared with forests, watersheds, farmland and other fields, there are relatively few studies on grassland eco-compensation around the world. In 2011, in order to restore the ecological function of grassland and promote the sustainable development of livestock husbandry, China officially established the grassland eco-compensation mechanism [30]. It has set a model for global grassland ecological protection and has attracted the attention of many scholars [31,32]. Facing this new field, this study aims to explore the connotation and effects of grassland eco-compensation in China by reviewing the current research. Then, according to the results, we point out the shortcomings of the current research and provide ideas for the future work.

2. Overview of Grassland Eco-Compensation in China

Grassland eco-compensation in China was first officially proposed at the executive meeting of the State Council on 12 October 2010. The meeting pointed out that due to long-term overgrazing and insufficient investments in grassland ecological protection, China's grasslands are seriously degraded. At the same time, due to the single employment (livestock husbandry), the income growth of herder households is slow. Therefore, since 2011, the central government has paid a large amount of funds every year (over 170 billion yuan by 2021) to implement grassland eco-compensation in China's pilot pastoral areas. The framework of grassland eco-compensation is that the government provides financial support to herder households, encourages them to transform livestock husbandry, and then reduces the grazing intensity of natural grasslands to restore ecological functions. The core measure is to divide the natural grasslands in the pilot area into grazing prohibition (GP) areas and grass–livestock balance (GLB) areas. GP areas are prohibited from grazing or allow very little grazing in some areas, and the government provides subsidies for the grassland contractors. As for GLB areas, the local management department gives reasonable grazing limits according to the current situation of grassland resources. Then, the government provides rewards to contractors who comply with the limits.

Since a large number of the papers are presented in Chinese, this study briefly describes the research overview of eco-compensation through the CNKI (China national knowledge infrastructure) database. We set the topic as "Payments for (Grassland) Ecosystem Service or (Grassland) Eco-Compensation or (Grassland) Ecological Protection Compensation or (Grassland) Ecological Product Value Realization". Journal sources include SCI, EI, CSCD and CSSCI, and the papers sampled included those published up to 2021. In the end, a total of 3902 research papers were retrieved (Figure 1). The results show that eco-compensation research can be traced back to 1998, entered a rapid development stage from 2004 to 2009, and then stabilized. Among these papers, 267 are related to grassland eco-compensation, accounting for 6.84% of the total. They were first seen in 2005, and have remained relatively stable in number since 2009.
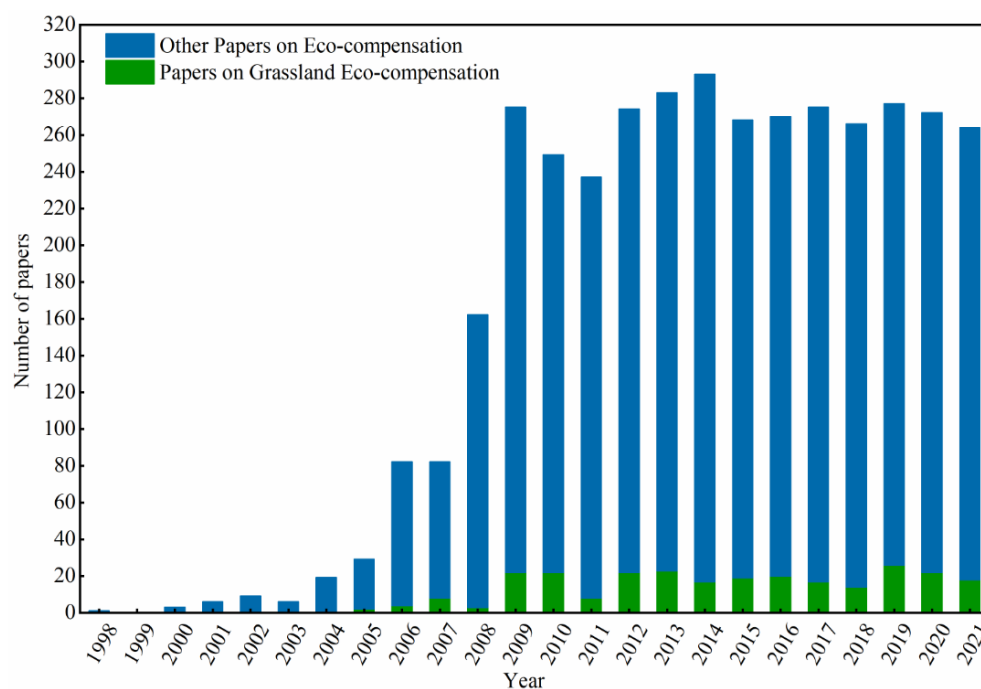
Figure 1. Overview of Eco-Compensation Research.

Therefore, although the Chinese government attaches great importance to grassland eco-compensation, it is still relatively lacking in the eco-compensation research field as a whole, and it is necessary to sort out the existing papers and provide ideas for subsequent research. This study aims to explore the connotations and effects of grassland eco-compensation in China. Section 3 summarizes the research progress of grassland eco-compensation theory in China. Specifically, the concept of eco-compensation is first obtained by comparing with PES, which is used internationally (Section 3.1). Then, combined with the characteristics of grassland eco-compensation (Section 3.2), the connotations of grassland eco-compensation in China are summarized (Section 3.3). Section 4 presents the research progress in grassland eco-compensation practice in China. Specifically, the connotations of eco-compensation are used to interpret the current China grassland eco-compensation policy (Section 4.1), and then, combined with the evaluation research of the policy in four aspects (Section 4.2), the effects of China's grassland eco-compensation are obtained (Section 4.3). Finally, according to the conclusion (Section 5) and the insufficiencies of the current research (Sections 3.3 and 4.3), this study provides three important directions for future work (Section 6).

3. Progress in Theoretical Research on Grassland Eco-Compensation in China

3.1. The Connotation of Ecological Compensation in China

Eco-compensation in China is similar to the concept of PES widely used around the world, but there are still some differences between the two [33,34]. For PES, although scholars have not formed a unified understanding, many studies agree that PES is an effective economic means to ensure the sustainable supply of ecosystem services [35–37]. It links the private interests of landowners with the public benefits of conservation managements [38]. The basic framework of PES is to provide financial incentives for private landowners to implement conservation measures that continue to provide critical ecosystem services (e.g., climate regulation, nutrient cycling, water conservation, etc.) [39].

As for China's eco-compensation, the widely accepted definition holds that "eco-compensation is a public institutional arrangement that uses government and market means to regulate the interests of ecological protection stakeholders. It aims to protect the ecology and promote the harmonious development of humans and nature, and formulate standards according to the value of ecosystem services, ecological protection costs, and development opportunity costs" [13]. From this definition, both eco-compensation and PES are processes that treat ecosystem services as commodities and are traded among stakeholders. Additionally, the goals of both are to achieve the sustainable supply of ecosystem services and protect the interests of suppliers [37]. However, the two are not exactly equivalent. First, eco-compensation has a wider application range than PES. PES is mainly about rewarding conservation behaviors of ecosystem services, but eco-compensation also includes charging for behaviors that damage ecosystem services [40]. Secondly, PES emphasizes voluntariness and belongs to a typical incentive mechanism. However, eco-compensation in China is often a strict public system arrangement. It is a large-scale eco-economic project that is led, managed, and guided by governments [41]. We take the grassland eco-compensation involved in this study as an example. Among the two core measures, GLB is to reward the herder households who reach the reasonable grazing limits, which is similar to PES. However, for GP, the regulation stipulates that grazing is not allowed in the designated area, which has a certain degree of compulsion. This distinction is based on China's current national conditions and the special historical period of ecological civilization construction. A certain degree of compulsion, on the one hand, can help many residents in ecologically fragile areas with relatively low levels of education realize the importance of ecological protection, and on the other hand can support them to increase their income. In conclusion, although there are many similarities, China's eco-compensation has wider application scope and stricter policy measures than PES.

3.2. Research Progress of Grassland Eco-Compensation Theory in China

Referring to relevant definitions and research frameworks, the current theoretical research on eco-compensation mainly includes five aspects: compensation goals, compensation main bodies, compensation standards, compensation methods, and compensation systems [34,42–44]. Therefore, this study will sort the research based on these five aspects.

3.2.1. Research on Compensation Goals

In recent decades, China's grasslands have been severely degraded [45]. Human activities, represented by overgrazing, are believed to be the dominant factor behind this phenomenon [46,47]. Therefore, the restoration of grassland ecosystem services through management has naturally become the basic goal of eco-compensation [48]. However, herder households are one of the core stakeholders in grassland eco-compensation. To solve the problem of negative externalities of grassland ecosystem services, it is necessary to coordinate the relationship between herder households and grasslands. Therefore, some scholars believe that improving the livelihood of herder households should also be one of the goals of grassland eco-compensation [49]. On the other hand, according to the instructions of the central government and related documents, grassland eco-compensation should consider ecological protection and income growth at the same time [30]. Compensation

funds should be directed towards poverty-stricken areas and populations [50]. On the whole, the goals of grassland eco-compensation should include the restoration of ecological functions and increasing the income of herder households.

3.2.2. Research on Compensation Main Bodies

The main bodies of eco-compensation include the suppliers and buyers of ecosystem services. Different land use patterns affect the provision of ecosystem services. Therefore, it is generally believed that the potential provider of ecosystem services is the owner/user of the land [51]. For grassland eco-compensation, the contributors to grassland protection, the losers relating to grassland ecosystem destruction, and the builders of grassland ecological industries are mainly herder households [48]. Therefore, herder households are undoubtedly the providers of grassland ecosystem services. As for the buyers of ecosystem services, these can be either a clear ecosystem service user or a third-party (such as the government) ecosystem service user [51]. However, studies have shown that government compensation is more effective than user compensation as the scope of compensation expands [52,53]. Therefore, for grassland eco-compensation in China, having the government as the buyer of ecosystem services is a better choice [54]. In summary, the main bodies of grassland eco-compensation in China are the government and herder households.

3.2.3. Research on Compensation Standards

Compensation standards are one of the core contents of eco-compensation. China is rich in grassland resources, and various types face different degrees of degradation. Scholars have chosen different pilot pastoral areas to study grassland eco-compensation standards (Table 1).

Table 1. Summary table of studies on grassland eco-compensation standards in China.

Management Measure	Scholar	Research Area	Calculation Method	Theoretical Standard (Yuan/ha)
Grazing prohibition	Qi et al. [55]	Xilin Gol, Inner Mongolia	Willingness to be paid	270
	Hu et al. [56]	3 counties including Siziwang Banner, Inner Mongolia	Opportunity cost	123.15
	Wei and Zong [57]	Maqu County, Gansu	minimum data	1751.7
	Yang et al. [58]	Xilin Gol, Inner Mongolia	Willingness to be paid	85.95
	Gong et al. [59]	Inner Mongolia Autonomous Region	Opportunity cost	713.25
Grass-livestock balance	Qi et al. [55]	Xilin Gol, Inner Mongolia	Willingness to be paid	135
	Wei and Qi [60]	Maqu County, Gansu	Opportunity cost	330
	Wei and Qi [61]	Maqu County, Gansu	Willingness to be paid	189.15
	Zhou et al. [62]	5 counties including Shanshan, Xinjiang	Willingness to be paid	130.5

Among the calculation methods, the willingness to be paid method allows the households to personally assess the impacts of the eco-compensation measures on the original production methods, and then gives the expected compensation standards. The opportunity cost method involves calculating the economic losses of the households due to the response to eco-compensation measures through the researchers' surveys, which are mainly the livestock income that should have been generated by livestock reduction. The minimum data method first specifies the target ecosystem service values to be restored, and then calculates the required compensation standards. There are pros and cons to each of these methods, but generally, algorithms that consider the value of ecosystem services will receive higher theoretical compensation standards. The theoretical compensation stan-

dards obtained through the willingness to pay method or the opportunity cost method are relatively low. Accordingly, the task force on eco-compensation mechanisms and policies suggests that the basic criterion for determining the eco-compensation standard should be lower than the ecosystem service values and higher than or equal to the opportunity costs and restoration costs [5].

3.2.4. Research on Compensation Methods

Compensation methods determine the efficiency of compensation, which can be divided into financial compensation and industrial compensation [19,63]. Financial compensation is a way to directly provide subsidies for herder households and encourage them to transform traditional livestock husbandry. However, such compensation's effect is always inefficient, because it is difficult for herder households to spontaneously change the current production status without the support of training, supervision, equipment, etc. [64,65]. Industrial compensation is currently in the exploratory stage, and its purpose is to help herder households get rid of their dependence on traditional livestock husbandry. The government can help them to upgrade their industries or obtain alternative incomes by providing policies, technologies, and equipment [44]. This is conducive to fundamentally solving the problem, but it is obviously more difficult than financial compensation.

However, no matter what compensation method is ultimately chosen, financial compensation in the short term is inevitable. There are two ways to allocate funds for grassland eco-compensation, namely the quota based on the grassland scale of the households or the quota based on household population [66]. Both ways have their pros and cons. A quota based on the grassland scale can better reflect the ecosystem service values and opportunity cost provided by herder households, but it is easy to widen the income gap between households [31]. A quota based on the household population will be relatively balanced, but it ignores opportunity costs [66]. At present, a fund allocation method that is both balanced and can reflect the opportunity costs of households is still being explored [67].

3.2.5. Research on Compensation Systems

A complete compensation system is a necessary condition to ensure the progress of grassland eco-compensation [68]. After sorting out previous studies, China's grassland eco-compensation system should include the following important contents. The first is the legal system. With the continuous development of compensation, existing laws and regulations should also keep pace with the times to form a legal system that can cover the entire process of grassland eco-compensation [69]. The second is a strong supervision system. Without strict supervision measures, the implementation efficiency of grassland eco-compensation is likely to be low, and it is difficult to achieve the desired effects [70]. The third is strong scientific and technological support. The transformation of production methods has greatly increased the requirements for production technology. Herder households need more production training to adapt to such transformation [71]. The fourth is a long-term mechanism. Fundamentally curbing overload cannot be achieved in a short period of time, and requires a long-term compensation mechanism to continue to advance [71].

3.3. Summary and Analysis of Theoretical Research

Combined with relevant conclusions, we can conclude that the current grassland eco-compensation in China is a large-scale ecological-economic institutional arrangement with the following five characteristics: (1) the goals are to maintain the grassland ecosystem services and increase the income of herder households; (2) the main bodies are governments and herder households; (3) the main method is financial transfer payments; (4) the compensation standards are based on the opportunity costs of the herder households' responses as the lower limits and the grassland ecosystem service values as the upper limits; and (5) it is a comprehensive compensation system that requires legal, regulatory, technological support and long-term mechanisms.

Although a lot of progress has been made in the research on grassland eco-compensation in China, there are still some aspects to be improved. According to the framework of the compensation, the government provides financial support to herder households, encourages them to transform livestock husbandry, and then reduces the grazing intensity of natural grasslands to restore ecological functions. We can divide such a mechanism into two processes, namely the compensation process of the government (government–household) and the response process of herder households (household–grassland).

The current research on the government compensation process has covered the five basic aspects. Among them, the determination of compensation goals, the identification of the main compensation bodies and the needs of compensation systems have almost reached a consensus between scholars. However, the research on compensation standards and compensation methods is still weak. As one of the core issues of the eco-compensation mechanism, the current research on compensation standards only provides a reasonable compensation range (more than or equal to the opportunity costs and less than the ecosystem service values) through different calculation methods. However, such a large range is not enough to be a scientific basis for guiding practice. The final scientific standards should be precise. In addition, due to the large area of pastoral areas in China, there are many differences between nature and social status. It is necessary for governments at all levels to formulate differentiated compensation standards according to regional characteristics. However, the current research is not enough to meet such a requirement. After the compensation standards are clarified, multiple compensation methods are also essential. If a single government compensation method is maintained for a long time, it will inevitably bring a huge burden to the government's finances. Finding how to give full play to the advantages of the market is an important basis for realizing the long-term mechanisms of grassland eco-compensation, but this cannot be supported by the current research on compensation methods.

As for the response process of herder households, there are very few related studies. Some scholars found that when many herder households in pilot areas received compensation and did not reduce livestock as required, they often attributed the reason to the lack of a supervision system [64,65]. We agree that strong supervision will certainly help herder households to reduce livestock and improve compensation efficiency. However, achieving full supervision in the 255 million ha pilot area would mean significant costs. In addition, current research cannot guarantee whether the long-term strict supervision will bring about other social and economic problems. Therefore, it is necessary to explore a rational method for motivating households to respond to compensation.

## 4. Research Progress on Grassland Eco-Compensation Practice

4.1. Status of Compensation Policy

China's grassland eco-compensation is promoted by the policy of subsidies and rewards for grassland ecological protection (PSRGEP), officially launched in 2011 (Figure 2). Currently, about 255 million hectares of natural grassland in 13 pilot provinces/autonomous regions are divided into GP areas and GLB areas. The unified standard given by the central government is a GP subsidy of 112.5 yuan/ha and a GLP reward of 37.5 yuan/ha. However, in the process of implementation, the government also encourages each pilot area to make appropriate adjustments from these unified standards according to local circumstances. In addition, in order to promote the transformation and development of livestock husbandry, the government also provides subsidies for planting grass, optimizing species, and updating production materials for households in the pilot areas.

4.2. Resrearch of Compensation Effects

China's PSRGEP has been implemented for more than 11 years. Scholars chose different perspectives to evaluate the compensation effects, mainly focusing on the following four aspects: changes in household income, changes in grassland ecology, effect of households' reduction in livestock, and degree of households' satisfaction. We have reviewed typical

effect evaluation studies. In order to visualize the results, the evaluation result grades were set according to the conclusions of the studies (Table 2).
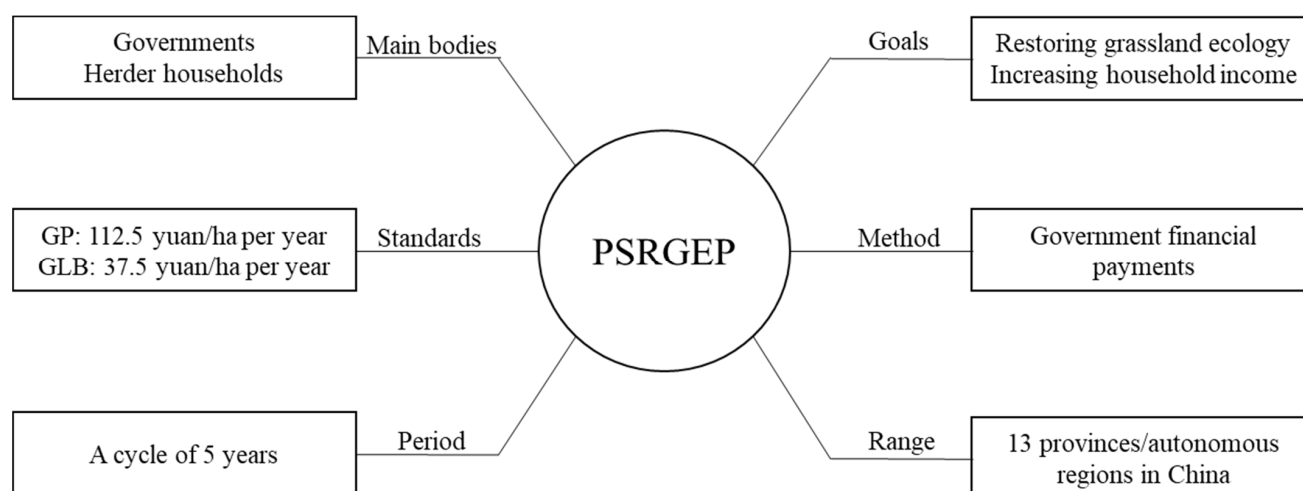
Figure 2. Overview of PSRGEP.

Table 2. Grading criteria for compensation effects.

Indicator	Good	Moderate	Poor
Income change	Average income increases of more than 10%	Average income changes less than 10%	Average income decreases of more than 10%
Ecological improvement	Evaluation results are positive and significant	Evaluation results are not significant	Evaluation results are negatively significant
Livestock reduction	Average reduction in livestock by more than 10%	Average stocking rates vary by less than 10%	Average increase in livestock by more than 10%
Satisfaction level	Satisfied with more than 60% of households	Satisfied households between 40–60%	Satisfied with less than 40% of households

Since 2011, the Chinese government has invested more than 170 billion yuan in the grassland eco-compensation mechanism, benefiting more than 12 million farmer and herder households, and rehabilitating 255 million hectares of grasslands [72]. Overall, China's grassland eco-compensation has achieved remarkable results [73] (Table 3). First, through the method of financial compensation, grassland eco-compensation has directly and effectively improved the income level of herder households [74,75]. Additionally, there is a positive correlation between the extent of the improvement and the amount of compensation funds [65]. As for the ecological changes to grassland, in the past 10 years, scholars have shown the overall improvement of grassland ecology in China through various indicators such as the NDVI index, grassland comprehensive vegetation coverage, theoretical stocking capacity calculated by remote sensing technology and grassland monitoring data [76,77]. However, the effect is relatively slight [78]. Therefore, the grassland eco-compensation mechanism has positively achieved the two main compensation goals overall. Of course, there are also some areas at the micro level that have negative income or ecological effects [77,79].

As for the livestock reduction and satisfaction level of herder households, although they do not directly feedback the goals of compensation, they also affect the efficiency and effects of eco-compensation. Many households in the pilot areas have a long-term dependence on traditional livestock husbandry. Therefore, compared with the change in income, the current effect of reducing livestock is not obvious [64,65,80]. Finally, the satisfaction degree of the households to grassland eco-compensation varies in different

regions. The influencing factors mainly include family income, policy cognition, family grassland scale and so on [81,82].

Table 3. Results of PSRGEP effect evaluations.

Indicator	Scholars	Research Area	Grade
Income change	Yin [74]	Urat Back Banner, Inner Mongolia	Good
	Zhang et al. [83]	Xinjiang Autonomous Region	Good
	Liu and Zhang [79]	4 cities including Ordos, Inner Mongolia	Good
Ecological improvement	Liu et al. [76]	54 counties, Inner Mongolia	Good
	Hou et al. [78]	All pilots in China	Good
	Liu [77]	73 counties, Inner Mongolia	Moderate
Livestock reduction	Gao et al. [65]	70 villages, Inner Mongolia	Moderate
	Yin et al. [32]	15 counties including New Barag Left Banner, Inner Mongolia	Poor
	Zhang et al. [84]	8 counties including Siziwang Banner, Inner Mongolia	Good
Satisfaction level	Li et al. [85]	Siziwang Banner, Inner Mongolia	Moderate
	Yang et al. [82]	6 counties including Tianzhu, Gansu	Good
	Hu et al. [86]	3 counties including Siziwang Banner, Inner Mongolia	Moderate

4.3. Summary and Analysis of Practical Research

China's PSRGEP is a practice closely integrated with grassland eco-compensation theory. Because of the huge investment, wide coverage and large number of beneficiaries, scholars pay great attention to its effects. Current studies accurately reflect the status of PSRGEP in pilot areas in China. The results show that with the background of PSRGEP, the income of herder households increased significantly and the grassland ecology slightly improved. It is difficult to fundamentally curb the phenomenon of overgrazing, and there are regional differences in the degree of satisfaction of herder households with the policy.

However, the status is not a real effect. Taking grassland ecological improvement as an example, on the one hand, the analysis of the status cannot reflect the efficiency of compensation. The current study suggests that the grassland ecological quality has slightly improved after compensation—for example, the increase in grassland vegetation coverage obtained through the NDVI index measured by remote sensing and the increase in theoretical stocking capacity obtained through grassland biomass monitoring [76–78]. However, no study can draw definite conclusions: is this improvement enough to match the financial investment of more than 170 billion yuan? Is the current level of compensation the most appropriate? Regrettably, current research cannot link compensation measures and compensation effects well. On the other hand, the analysis of status cannot highlight the role of compensation. Scholars always only use eco-compensation as a time boundary for comparison when evaluating grassland ecological improvement. Such results are caused by both natural and human factors. For example, the impact of climate change on ecosystems cannot be ignored. So how do we strip away other factors and focus on the real effect of eco-compensation? There are few relevant studies. Likewise, grassland eco-compensation significantly increases the income of herder households. However, it is worth noting that what the government provides for GP and GLB is compensation, not donations. The income increases of herder households due to grassland eco-compensation should be reflected in sustainable industrial transformation and upgrading. However, the existing studies rarely integrate the change in income with the actual production. If the households just received the compensation funds and did not respond to the compensation, such an increase in income would not be sustainable and cannot reflect the real effects of eco-compensation. Therefore, it is difficult to reflect the role of eco-compensation in the current effect evaluations.

5. Conclusion and Discussion

In summary, this study sorts the relevant theoretical and practical research in recent years, explains the connotations of grassland eco-compensation in China from five aspects,

and then evaluates the effects from four perspectives. The results show that the current grassland eco-compensation in China is a large-scale ecological-economic institutional arrangement with the following five characteristics: (1) The goals are to maintain the grassland ecosystem services and increase the income of herder households; (2) the main bodies are governments and herder households; (3) the main method is financial transfer payments; (4) the compensation standards are based on the opportunity costs of the herder households' responses as the lower limits and the grassland ecosystem service values as the upper limits; and (5) it is a comprehensive compensation system that requires legal, regulatory, technological support and long-term mechanisms. Since 2011, driven by the PSRGEP, the income levels of herder households in each pilot area have generally increased, and the overall ecology of grassland has been slightly improved. However, there are still some areas where overload is common. Additionally, there are regional differences in the satisfaction degree of herder households, which is mainly affected by factors such as family income, compensation cognition and family grassland scale. In general, the shortcomings of current theoretical research are mainly reflected in the low precision of scientific compensation standards, the lack of a basis for differentiated standards, and the single compensation method. The shortcoming of practical research is that most effect evaluations cannot reflect the role of eco-compensation in it.

In December 2021, China officially started the third round of its grassland eco-compensation policy. At the important beginning stage of the third round, this study can provide a reference for policymakers to comprehensively review China's grassland eco-compensation mechanism in the first two rounds.

As for the academic contribution of this research, it mainly includes the following two aspects: the first is providing supplements for the field of eco-compensation. Grassland is the largest terrestrial ecosystem, but it is relatively lacking in the field of eco-compensation research. This study sorts the theory and practice of grassland eco-compensation in China, and points out the insufficiency of the current research, so as to provide directions for the improvement of grassland eco-compensation research system. The second is setting out a model for grassland ecological protection. Grassland degradation is occurring in many regions of the world. The exploration of grassland eco-compensation in China can provide a reference for global grassland ecological protection.

6. Future work

Combined with the current research status and the problems in the compensation process, we suggest that future research on grassland eco-compensation theory and practice could focus on the following aspects:

1. Research on the response mechanism of herder households

The response of herder households is the core link of grassland eco-compensation in China, which determines the efficiency and effect of compensation to a large extent. Whether it is the problem of overgrazing being difficult to solve, or the compensation effect being difficult to describe, the key reason is that the response mechanism of herder households is still unclear. We believe that this mechanism can be divided into three steps. First, how do the households respond? Current research is almost exclusively concerned with livestock reduction. However, in fact, herder households have various forms of response compensation, such as the optimization of livestock structure, the optimization of livestock breeds, land transfer, and the development of grass growing industry [30]. These forms are also advocated by PSRGEP, which are beneficial to grassland ecological protection and worth attention from scholars. Second: what factors influence the response of the herder households? The response of herder households to eco-compensation is a complex process that may involve many theories such as livelihood strategies and planned behaviors. Taking livelihood strategies as an example, according to the sustainable livelihood framework, the factors affecting the response strategies (such as livestock reduction) of farmers may not be limited to public policies, but may also include other direct and indirect factors such as the vulnerable environment [87], livelihood assets [88], and other institutional

changes [89]. Finding out the influencing factors or processes affecting livestock reduction by herder households may help to improve the supporting policies and achieve a more ideal compensation effect. Finally, the livelihood and ecological effects of the households' response are important. Compensation has changed the production and living conditions of the herder households. To study the resulting livelihood and ecological effects is to evaluate the compensation effect from the perspective of compensation mechanism, which obviously highlights the role of eco-compensation more than the current evaluation results [90]. Macroscopically, pastoral areas not included in the compensation pilots can be used as the reference group for adjacent compensation pilots. Microscopically, the herder households who did not respond to the compensation in the same pilot area can be the reference group for the households who responded to the compensation. Such a series of studies will help us to better improve the compensation theory and examine the effects of compensation. In addition, the existing ecological effect research only focuses on the grassland resources itself. However, other ecological effects brought about by compensation management are also worthy of attention, such as the impacts on the soil environment and the impacts on carbon emissions from livestock husbandry.

2.   Improvement of the compensation measures

Compensation standards and compensation methods are the core contents of eco-compensation measures [91,92]. The current calculation methods of compensation standards include the willingness to pay method, the opportunity cost method, and the ecological service accounting method, which correspond to the relevant theories of psychology, economics and ecology. The results obtained by a single theory are very different and have obvious limitations. Therefore, we suggest that future research should try to combine multidisciplinary theories to form a unified comprehensive accounting system. The system should consider the existing mature theories as well as the government's financial ability to pay, the livelihood status of the herder households, the ecological status, and other restrictive factors. Performing this work not only helps to improve the scientific quality of theoretical standards, but also enhances the comparability between regions and provides a basis for differential compensation. For the compensation methods, it is difficult to form a stable long-term mechanism with a single government compensation. Future research could focus on market compensation mechanisms, which can include the following three aspects: first, research on the confirmation and registration of grassland resources, specifically how to establish clear ownership of grassland and improve the property rights system of grassland assets to provide conditions for the establishment of the market mechanism; second, research on market-based financing methods, exploring the feasibility green stocks and insurance products based on grassland ecological functions; and third, research on industries with grassland characteristics, exploring the grassland ecological industry chain financial model and the livestock husbandry franchise management system.

3.   Expand the scope of research and learn from successful experiences

At present, there are 13 pilot provinces for grassland eco-compensation in China, but the research area selected by scholars are mainly concentrated in Inner Mongolia, Gansu and Ningxia, relatively few in Xinjiang and Tibet, and almost none in other provinces. Here, we suggest that the scope of research should be expanded. On the one hand, different regions may expose different problems in the compensation process, and exploring more pilots can be an easy way to discover details that have been overlooked in theoretical research. On the other hand, when the research scope is expanded to a certain level, it helps to enhance the comparability between regions with similar background conditions. Researchers can select successful cases to provide a model for guiding compensation practices in other regions. In addition, China's grassland eco-compensation started in 2011 and is still in the stage of exploration and development. However, eco-compensation in other areas can be traced back to the 1990s or even earlier. Future research should try to combine eco-compensation experience in other fields with grassland research. For example, forest ecological compensation has practical experience in several major projects [93–95]. Watershed eco-compensation has

cooperation experience between different regions [96–98]. Marine eco-compensation has legislative experience [99,100]. Farmland ecological compensation has good effect evaluation experience [101–103]. Furthermore, there is also international experience in specialized payments for various ecosystem services, such as biodiversity conservation [104,105], water provision [106], carbon dioxide fixation [107]. Absorbing these advanced experiences will accelerate the improvement of grassland eco-compensation in China.

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References

1. Costanza, R.; d'Arge, R.; de Groot, R.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O'Neill, R.V.; Paruelo, J.; et al. The value of the world's ecosystem services and natural capital. *Nature* **1997**, *387*, 253–260. [CrossRef]
2. Buchanan, J.M.; Stubblebine, W.C. Externality. *Economica* **1962**, *29*, 371–384. [CrossRef]
3. Kosoy, N.; Martinez-Tuna, M.; Muradian, R.; Martinez-Alier, J. Payments for environmental services in watersheds: Insights from a comparative study of three cases in Central America. *Ecol. Econ.* **2007**, *61*, 446–455. [CrossRef]
4. Shang, W.; Gong, Y.; Wang, Z.; Stewardson, M.J. Eco-Compensation in China: Theory, practices and suggestions for the future. *J. Environ. Manag.* **2018**, *210*, 162–170. [CrossRef] [PubMed]
5. TFEMP. *Eco-Compensation Mechanisms and Policies in China*; Science Press: Beijing, China, 2008.
6. Ventrubová, K.; Dvořák, P. Legal framework for payments for forest ecosystem services in the Czech Republic. *J. For. Sci.* **2012**, *58*, 131–136. [CrossRef]
7. Phan, T.-H.D.; Brouwer, R.; Hoang, L.P.; Davidson, M.D. A comparative study of transaction costs of payments for forest ecosystem services in Vietnam. *For. Policy Econ.* **2017**, *80*, 141–149. [CrossRef]
8. To, P.; Dressler, W. Rethinking 'Success': The politics of payment for forest ecosystem services in Vietnam. *Land Use Policy* **2019**, *81*, 582–593. [CrossRef]
9. Cuperus, R.; Bakermans, M.M.G.J.; Haes, H.A.U.D.; Canters, K.J. Ecological Compensation in Dutch Highway Planning. *Environ. Manag.* **2001**, *27*, 75–89. [CrossRef]
10. Duelli, P.; Obrist, M.K. Regional biodiversity in an agricultural landscape: The contribution of seminatural habitat islands. *Basic Appl. Ecol.* **2003**, *4*, 129–138. [CrossRef]
11. Knop, E.V.A.; Kleijn, D.; Herzog, F.; Schmid, B. Effectiveness of the Swiss agri-environment scheme in promoting biodiversity. *J. Appl. Ecol.* **2005**, *43*, 120–127. [CrossRef]
12. Johst, K.; Drechsler, M.; Wätzold, F. An ecological-economic modelling procedure to design compensation payments for the efficient spatio-temporal allocation of species protection measures. *Ecol. Econ.* **2002**, *41*, 37–49. [CrossRef]
13. Li, W.; Liu, M. Several strategic thoughts on China's eco-compensation mechanism. *Resour. Sci.* **2010**, *32*, 791–796.
14. Sheng, W.; Zhen, L.; Xie, G.; Xiao, Y. Determining eco-compensation standards based on the ecosystem services value of the mountain ecological forests in Beijing, China. *Ecosyst. Serv.* **2017**, *26*, 422–430. [CrossRef]
15. Xiong, Y.; Wang, K. Eco-Compensation effects of the wetland recovery in Dongting Lake area. *J. Geogr. Sci.* **2010**, *20*, 389–405. [CrossRef]
16. Guan, X.; Liu, W.; Chen, M. Study on the ecological compensation standard for river basin water environment based on total pollutants control. *Ecol. Indic.* **2016**, *69*, 446–452. [CrossRef]
17. Yang, Y.; Yao, C.; Xu, D. Ecological compensation standards of national scenic spots in western China: A case study of Taibai Mountain. *Tour. Manag.* **2020**, *76*, 103950. [CrossRef]
18. Rao, H.; Lin, C.; Kong, H.; Jin, D.; Peng, B. Ecological damage compensation for coastal sea area uses. *Ecol. Indic.* **2014**, *38*, 149–158. [CrossRef]

19. Liu, M.; Liu, W.; Yang, L.; Jiao, W.; He, S.; Min, Q. A dynamic eco-compensation standard for Hani Rice Terraces System in southwest China. *Ecosyst. Serv.* **2019**, *36*, 100897. [CrossRef]

20. Yang, X.; Zhou, X.; Cao, S.; Zhang, A. Preferences in Farmland Eco-Compensation Methods: A Case Study of Wuhan, China. *Land* **2021**, *10*, 1159. [CrossRef]

21. O'Mara, F.P. The role of grasslands in food security and climate change. *Ann. Bot.* **2012**, *110*, 1263–1270. [CrossRef]

22. Ni, J. Forage Yield-Based Carbon Storage in Grasslands of China. *Clim. Change* **2004**, *67*, 237–246. [CrossRef]

23. Ni, J. Carbon storage in grassland of China. *J. Arid Environ.* **2002**, *50*, 205–218. [CrossRef]

24. Bardgett, R.D.; Bullock, J.M.; Lavorel, S.; Manning, P.; Schaffner, U.; Ostle, N.; Chomel, M.; Durigan, G.; Fry, E.L.; Johnson, D.; et al. Combatting global grassland degradation. *Nat. Rev. Earth Environ.* **2021**, *2*, 720–735. [CrossRef]

25. Cao, J.; Adamowski, J.F.; Deo, R.C.; Xu, X.; Gong, Y.; Feng, Q. Grassland Degradation on the Qinghai-Tibetan Plateau: Reevaluation of Causative Factors. *Rangel. Ecol. Manag.* **2019**, *72*, 988–995. [CrossRef]

26. Quinlan, T. Grassland degradation and livestock rearing in Lesotho. *J. S. Afr. Stud.* **2007**, *21*, 491–507. [CrossRef]

27. Abdalla, K.; Mutema, M.; Chivenge, P.; Everson, C.; Chaplot, V. Grassland degradation significantly enhances soil CO_2 emission. *Catena* **2018**, *167*, 284–292. [CrossRef]

28. Xu, X.; Hu, G.; Liu, X.; Lu, S.; Li, S.; Zhao, N. Impacts of nitrogen enrichment on vegetation growth dynamics are regulated by grassland degradation status. *Land Degrad. Dev.* **2021**, *32*, 4056–4066. [CrossRef]

29. Yang, S.; Hao, Q.; Liu, H.; Zhang, X.; Yu, C.; Yang, X.; Xia, S.; Yang, W.; Li, J.; Song, Z. Impact of grassland degradation on the distribution and bioavailability of soil silicon: Implications for the Si cycle in grasslands. *Sci. Total Environ.* **2019**, *657*, 811–818. [CrossRef]

30. The Executive Meeting of the State Council Decided to Establish a Subsidy and Reward Mechanism for Grassland Ecological Protection. Available online: http://www.mof.gov.cn/zhengwuxinxi/caijingshidian/zyzfmhwz/201010/t20101013_342428.htm (accessed on 10 March 2022).

31. Li, Z.; Rao, D.; Liu, M. The Impact of China's Grassland Ecological Compensation Policy on the Income Gap between Herder Households? A Case Study from a Typical Pilot Area. *Land* **2021**, *10*, 1405. [CrossRef]

32. Yin, Y.; Hou, Y.; Langford, C.; Bai, H.; Hou, X. Herder stocking rate and household income under the Grassland Ecological Protection Award Policy in northern China. *Land Use Policy* **2019**, *82*, 120–129. [CrossRef]

33. Chen, Y.; Dou, S.; Xu, D. The effectiveness of eco-compensation in environmental protection—A hybrid of the government and market. *J. Environ. Manag.* **2021**, *280*, 111840. [CrossRef] [PubMed]

34. Liu, D.; Hu, Z.; Jin, L. Review on analytical framework of eco-compensation. *Acta Ecol. Sin.* **2018**, *38*, 380–392. [CrossRef]

35. Garbach, K.; Lubell, M.; DeClerck, F.A.J. Payment for Ecosystem Services: The roles of positive incentives and information sharing in stimulating adoption of silvopastoral conservation practices. *Agric. Ecosyst. Environ.* **2012**, *156*, 27–36. [CrossRef]

36. Jack, B.K.; Kousky, C.; Sims, K.R.E. Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms. *Proc. Natl. Acad. Sci. USA* **2008**, *105*, 9465–9470. [CrossRef]

37. Yu, H.; Xie, W.; Yang, L.; Du, A.; Almeida, C.M.V.B.; Wang, Y. From payments for ecosystem services to eco-compensation: Conceptual change or paradigm shift? *Sci. Total Environ.* **2020**, *700*, 134627. [CrossRef]

38. Ferraro, P.J.; Kiss, A. Direct Payments to Conserve Biodiversity. *Science* **2002**, *298*, 1718–1719. [CrossRef]

39. Millennium Ecosystem Assessment (MEA). *Ecosystems and Human Well-Being*; Island Press: Washington, DC, USA, 2005.

40. Mao, X.; Zhong, Y.; Zhang, S. Conception, theory and mechanism of eco-compensation. *China Popul. Resour. Environ.* **2022**, *12*, 38–41.

41. Teets, J.C.; Gao, M.; Wysocki, M.; Ye, W. The impact of environmental federalism: An analysis of watershed eco-compensation policy design in China. *Environ. Policy Gov.* **2021**, *31*, 580–591. [CrossRef]

42. Cheng, X.; Fang, L.; Mu, L.; Li, J.; Wang, H. Watershed Eco-Compensation Mechanism in China: Policies, Practices and Recommendations. *Water* **2022**, *14*, 777. [CrossRef]

43. Liu, M.; Yang, L.; Min, Q.; Sang, W. Theoretical framework for eco-compensation to national parks in China. *Glob. Ecol. Conserv.* **2020**, *24*, e01296. [CrossRef]

44. Liu, M.; Rao, D.; Yang, L.; Min, Q. Subsidy, training or material supply? The impact path of eco-compensation method on farmers' livelihood assets. *J. Environ. Manag.* **2021**, *287*, 112339. [CrossRef]

45. Ruan, H.; Wu, X.; Wang, S.; Yang, J.; Zhu, H.; Guo, Q.; Wang, L.; Wang, D. The responses of different insect guilds to grassland degradation in northeastern China. *Ecol. Indic.* **2021**, *133*, 108369. [CrossRef]

46. Zhou, H.; Zhao, X.; Tang, Y.; Gu, S.; Zhou, L. Alpine grassland degradation and its control in the source region of the Yangtze and Yellow Rivers, China. *Grassl. Sci.* **2005**, *51*, 191–203. [CrossRef]

47. Li, S.; Verburg, P.H.; Lv, S.; Wu, J.; Li, X. Spatial analysis of the driving factors of grassland degradation under conditions of climate change and intensive use in Inner Mongolia, China. *Reg. Environ. Chang.* **2011**, *12*, 461–474. [CrossRef]

48. Yang, Q.; Nan, Z.; Chen, Q. Research progress of grassland ecological compensation in China. *Acta Ecol. Sin.* **2020**, *40*, 2489–2495. [CrossRef]

49. Jin, L.; Zhentong, H. Grassland ecological compensation policy and chooses of the herdsmen. *Reform* **2014**, *11*, 100–107.

50. The General Office of the State Council issued the "Opinions on Improving the Ecological Protection Compensation Mechanism". Available online: http://www.gov.cn/xinwen/2016-05/13/content_5073164.htm (accessed on 3 March 2022).

51. Engel, S.; Pagiola, S.; Wunder, S. Designing payments for environmental services in theory and practice: An overview of the issues. *Ecol. Econ.* **2008**, *65*, 663–674. [CrossRef]

52. Wunder, S.; Engel, S.; Pagiola, S. Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. *Ecol. Econ.* **2008**, *65*, 834–852. [CrossRef]

53. Schomers, S.; Matzdorf, B. Payments for ecosystem services: A review and comparison of developing and industrialized countries. *Ecosyst. Serv.* **2013**, *6*, 16–30. [CrossRef]

54. Pan, J. Subject and relationship of rights and obligations' connotataion for grassland eco-compensation. *J. HIT (Soc. Sci. Ed.)* **2015**, *17*, 37–44. [CrossRef]

55. Qi, X.; Gao, B.; Wang, H.; Zhou, J.; Qiao, G. The study on the compensation and award standards for forage-livestock balance and grazing prohibition based on herder's perspective of grassland ecological protection subsidies and incentives policies—Take Xilin Gol League as an example. *J. Arid Land Resour. Environ.* **2016**, *30*, 30–35. [CrossRef]

56. Hu, Z.; Liu, D.; Kong, D.; Jin, L. Rate calculation of "subsidies for grazing prohibition" in grassland eco-compensation based on opportunity cost method. *J. Arid Land Resour. Environ.* **2017**, *31*, 63–68. [CrossRef]

57. Wei, H.; Zong, X. Ecological compensation standard for graze-prohibited grassland: Application of the minimum data method in Maqu County. *J. Nat. Resour.* **2016**, *31*, 28–38. [CrossRef]

58. Yang, G.; Min, Q.; Li, W.; Liu, L.; Rong, J.; Wu, X. Herdsmen's willingness to accept (WTA) compensation for implement of prohibiting-graze policy in Xinlinguole steppe. *Ecol. Environ.* **2006**, *15*, 747–751. [CrossRef]

59. Gong, F.; Chang, Q.; Wang, F.; Liu, X. Empiricall study on compensation standard for grassland ecology in Inner Mongolia. *J. Arid Land Resour. Environ.* **2011**, *25*, 151–155. [CrossRef]

60. Wei, H.; Qi, Y. Analysis of grassland eco-compensation standard based on the differentiation of the opportunity losses caused by reducing livestock. *J. China Agric. Univ.* **2017**, *22*, 199–207. [CrossRef]

61. Wei, H.; Qi, Y. The analysisi of herddsmen's willingness to accept the reducing—Livestock policy based on the CVM. *J. Arid Land Resour. Environ.* **2017**, *31*, 45–50. [CrossRef]

62. Zhou, J.; Maimaiti, Z.; Pei, Y.; Zou, L. Analysis of herdsmen's willingness to accept the compensation standard of grassland-livestock balance: Based on a survey of 223 herdsmen in Xinjiang. *J. Arid Land Resour. Environ.* **2019**, *33*, 79–84. [CrossRef]

63. Liu, M.; Bai, Y.; Ma, N.; Rao, D.; Yang, L.; Min, Q. Blood transfusion or hematopoiesis? How to select between the subsidy mode and the long-term mode of eco-compensation. *Environ. Res. Lett.* **2020**, *15*, 094059. [CrossRef]

64. Feng, X.; Liu, M.; Qiu, H. Impact of grassland eco-compensation policy on herders' overgazing behavior. *China Popul. Resour. Environ.* **2019**, *29*, 157–165.

65. Gao, L.; Kinnucan, H.W.; Zhang, Y.; Qiao, G. The effects of a subsidy for grassland protection on livestock numbers, grazing intensity, and herders' income in inner Mongolia. *Land Use Policy* **2016**, *54*, 302–312. [CrossRef]

66. Kong, D.; Hu, Z.; Jin, L. Research on the allocation model for grassland eco-compensation fund: Based on the empirical analysis of 34 Gacha in Inner Mongolia. *J. Arid Land Resour. Environ.* **2016**, *30*, 1–6. [CrossRef]

67. Li, Z.; Liu, M. Research progress in the evaluation of policy of subsidy and reward for grassland ecological portection in China. *Acta Agrestia Sin.* **2021**, *29*, 1125–1135. [CrossRef]

68. Jiang, X.; Eaton, S.; Kostka, G. Not at the table but stuck paying the bill: Perceptions of injustice in China's Xin'anjiang eco-compensation program. *J. Environ. Policy Plan.* **2021**, 1–17. [CrossRef]

69. Li, J. The problems and strategy analysis of grassland ecological compensation system—A case of Gansu Province. *Pratacult. Sci.* **2015**, *32*, 1027–1032. Available online: https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CJFD&dbname=CJFDLAST2015&filename=CYKX201506025&uniplatform=NZKPT&v=0WwFkMcZ2UOSm3EN75siHpJLDW7Ei-ckeyK9yxzjpXQqf1SITYAg4OQmTKCb2RTM (accessed on 16 May 2022).

70. Hu, Z.; Kong, D.; Jin, L. Grasslamd eco-compensation: Game analysis under weak supervision. *Issues Agric. Econ.* **2016**, *37*, 95–102. [CrossRef]

71. Wang, J.; Wang, Z.; Xu, L.; Ding, Y. Problems and countermeasures in the implementation of grassland ecologic grant-premium mechanism based on investigation of household in Xilinhot. *Chin. J. Grassl.* **2016**, *38*, 1–7. [CrossRef]

72. The Office of the State Forestry and Grassland Administration and the General Office of the Ministry of Agriculture and Rural Affairs Jointly Issued a Notice. Implement the Third Round of Grassland Ecological Subsidy and Reward Policies. Available online: http://www.forestry.gov.cn/main/586/20211208/101325708851570.html (accessed on 11 March 2022).

73. The Grassland Ecological Protection Reward Policy has been Implemented for Ten Years, Benefiting More Than 12 Million Farmers and Herdsmen. Available online: http://www.forestry.gov.cn/main/586/20211206/084610261891386.html (accessed on 11 March 2022).

74. Yin, X. Implementation performance and suggestions of grassland eco0compensation policies: Based on Urat Back Banner, Inner Mongolia. *Ecol. Econ.* **2017**, *33*, 39–45.

75. Zhou, S.; Gao, Y.; Zhao, K. The impact of grassland ecological compensation on rural poor farmers and herdsmen's income. *J. Northwest AF Univ. (Soc. Sci. Ed.)* **2020**, *20*, 138–147. [CrossRef]

76. Liu, M.; Dries, L.; Heijman, W.; Huang, J.; Zhu, X.; Hu, Y.; Chen, H. The Impact of Ecological Construction Programs on Grassland Conservation in Inner Mongolia, China. *Land Degrad. Dev.* **2018**, *29*, 326–336. [CrossRef]

77. Liu, A. Inner Mongolia grassland ecological protection subsidy and reward effect and its problem analysis. *Grassl. Pratacult.* **2014**, *26*, 4–8.

78. Hou, L.; Xia, F.; Chen, Q.; Huang, J.; He, Y.; Rose, N.; Rozelle, S. Grassland ecological compensation policy in China improves grassland quality and increases herders' income. *Nat. Commun* **2021**, *12*, 4683. [CrossRef] [PubMed]

79. Liu, Y.; Zhang, X. Effect of grassland ecological protection subsidy policy on households' income. *J. Arid Land Resour. Environ.* **2019**, *33*, 60–67. [CrossRef]

80. Wang, H.; Gao, B.; Qi, X.; Qiao, G. Empirical analysis on the impact of the grassland ecological protection subsidies and incentives policies on herdsmen's reduced-livestock behavior: Based on the 260 herdsmen households in Inner Mongolia. *Issues Agric. Econ.* **2017**, *38*, 73–80. [CrossRef]

81. Ding, W.; Yang, Z.; Ma, C.; Li, X.; Yin, Y.; Hou, X. Satisfaction level, and factors influencing satisfaction of herdsmen with the grassland ecological protection subsidy incentive policy. *Acta Pratacult. Sin.* **2019**, *28*, 12–22. [CrossRef]

82. Yang, Q.; Nan, Z.; Chen, Q.; Tang, Z. Satisfaction and influencing factor to grassland eco-compensation and reward policies for herders: Empirical study in Qinghai-Tibet Plateau and western desert area of Gansu. *Acta Ecol. Sin.* **2020**, *40*, 1436–1444. [CrossRef]

83. Zhang, X.; Lu, J.; Gu, S.; Wang, L. Assessing the implementation effects of grassland eco-compensation in Xinjiang. *J. Arid Land Resour. Environ.* **2017**, *31*, 39–44. [CrossRef]

84. Zhang, J.; Brown, C.; Qiao, G.; Zhang, B. Effect of Eco-compensation Schemes on Household Income Structures and Herder Satisfaction: Lessons from the Grassland Ecosystem Subsidy and Award Scheme in Inner Mongolia. *Ecol. Econ.* **2019**, *159*, 46–53. [CrossRef]

85. Li, Y.; Wei, T.; Jin, L. Herdspeople attitudes towards grassland eco-compensation policies in Siziwang Banner, Inner Mongolia. *Resour. Sci.* **2014**, *36*, 2442–2450.

86. Hu, Z.; Liu, D.; Jin, L. Grassland eco-compensation: Ecological performance, income effect and policy satisfaction. *China Popul. Resour. Environ.* **2016**, *26*, 165–176.

87. Mubaya, C.P.; Mafongoya, P. Local-Level climate change adaptation decision-making and livelihoods in semi-arid areas in Zimbabwe. *Environ. Dev. Sustain.* **2017**, *19*, 2377–2403. [CrossRef]

88. Ellis, F. Household strategies and rural livelihood diversification. *J. Dev. Stud.* **1998**, *35*, 1–38. [CrossRef]

89. Korah, P.I.; Nunbogu, A.M.; Akanbang, B.A.A. Spatio-Temporal dynamics and livelihoods transformation in Wa, Ghana. *Land Use Policy* **2018**, *77*, 174–185. [CrossRef]

90. Li, Z.; Liu, M. Livelihood Diversification Helps Herder Households on the Mongolian Plateau Reduce Emissions: A Case Study of a Typical Pastoral Area. *Agronomy* **2022**, *12*, 267. [CrossRef]

91. Gao, X.; Shen, J.; He, W.; Sun, F.; Zhang, Z.; Zhang, X.; Zhang, C.; Kong, Y.; An, M.; Yuan, L.; et al. Changes in Ecosystem Services Value and Establishment of Watershed Ecological Compensation Standards. *Int. J. Environ. Res. Public Health* **2019**, *16*, 2951. [CrossRef]

92. Gastineau, P.; Mossay, P.; Taugourdeau, E. Ecological compensation: How much and where? *Ecol. Econ.* **2021**, *190*, 107191. [CrossRef]

93. Ouyang, Z.; Zheng, H.; Xiao, Y.; Polasky, S.; Liu, J.; Xu, W.; Wang, Q.; Zhang, L.; Xiao, Y.; Rao, E.; et al. Improvements in ecosystem services from investments in natural capital. *Science* **2016**, *352*, 1455–1459. [CrossRef]

94. Deng, H.; Zheng, P.; Liu, T.; Liu, X. Forest Ecosystem Services and Eco-Compensation Mechanisms in China. *Environ. Manag.* **2011**, *48*, 1079–1085. [CrossRef]

95. Trac, C.J.; Schmidt, A.H.; Harrell, S.; Hinckley, T.M. Environmental Reviews and Case Studies: Is the Returning Farmland to Forest Program a Success? Three Case Studies from Sichuan. *Environ. Pract.* **2017**, *15*, 350–366. [CrossRef]

96. Wang, Q.; Wang, N.; Wang, H.; Xiu, Y. Study on Influencing Factors and Simulation of Watershed Ecological Compensation Based on Evolutionary Game. *Sustainability* **2022**, *14*, 3374. [CrossRef]

97. Shen, J.; Gao, X.; He, W.; Sun, F.; Zhang, Z.; Kong, Y.; Wan, Z.; Zhang, X.; Li, Z.; Wang, J.; et al. Prospect theory in an evolutionary game: Construction of watershed ecological compensation system in Taihu Lake Basin. *J. Clean. Prod.* **2021**, *291*, 125929. [CrossRef]

98. Gao, X.; Shen, J.; He, W.; Sun, F.; Zhang, Z.; Guo, W.; Zhang, X.; Kong, Y. An evolutionary game analysis of governments' decision-making behaviors and factors influencing watershed ecological compensation in China. *J. Environ. Manag.* **2019**, *251*, 109592. [CrossRef] [PubMed]

99. Wang, Y.; Zou, K. Compensation for Marine Ecological Damage: From 'Tasman Sea' to 'Sanchi'. *Sustainability* **2021**, *13*, 13353. [CrossRef]

100. Qu, Q.; Tsai, S.-B.; Tang, M.; Xu, C.; Dong, W. Marine Ecological Environment Management Based on Ecological Compensation Mechanisms. *Sustainability* **2016**, *8*, 1267. [CrossRef]

101. Zheng, H.; Robinson, B.E.; Liang, Y.-C.; Polasky, S.; Ma, D.-C.; Wang, F.-C.; Ruckelshaus, M.; Ouyang, Z.-Y.; Daily, G.C. Benefits, costs, and livelihood implications of a regional payment for ecosystem service program. *Proc. Natl. Acad. Sci. USA* **2013**, *110*, 16681–16686. [CrossRef]

102. Zhu, L.; Zhang, C.; Cai, Y. Varieties of agri-environmental schemes in China: A quantitative assessment. *Land Use Policy* **2018**, *71*, 505–517. [CrossRef]

103. Liu, M.; Chen, C.; Yang, L.; Min, Q.; Xiong, Y. Agricultural eco-compensation may not necessarily reduce chemical inputs. *Sci. Total Environ.* **2020**, *741*, 139847. [CrossRef]

104. Narloch, U.; Drucker, A.G.; Pascual, U. Payments for agrobiodiversity conservation services for sustained on-farm utilization of plant and animal genetic resources. *Ecol. Econ.* **2011**, *70*, 1837–1845. [CrossRef]

105. Wätzold, F.; Drechsler, M.; Johst, K.; Mewes, M.; Sturm, A. A Novel, Spatiotemporally Explicit Ecological-economic Modeling Procedure for the Design of Cost-effective Agri-environment Schemes to Conserve Biodiversity. *Am. J. Agric. Econ.* **2015**, *98*, 489–512. [CrossRef]
106. Prokopy, L.S.; Floress, K.; Klotthor-Weinkauf, D.; Baumgart-Getz, A. Determinants of agricultural best management practice adoption: Evidence from the literature. *J. Soil Water Conserv.* **2008**, *63*, 300–311. [CrossRef]
107. Corbera, E.; Kosoy, N.; Martínez Tuna, M. Equity implications of marketing ecosystem services in protected areas and rural communities: Case studies from Meso-America. *Glob. Environ. Chang.* **2007**, *17*, 365–380. [CrossRef]