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Grassland Transfer and Its Income Effect: Evidence from Pastoral Areas of the Qinghai–Tibet Plateau

Zeng Tang [1], Shiqi Guan [2], Menglin Zhao [1], Lijia Wang [1], Ying Liu [3] and Yubing Fan [1,*]

[1] State Key Laboratory of Herbage Improvement and Grassland Agro-Ecosystems, China Grass Industry Development Strategy Research Center, College of Pastoral Agriculture Science and Technology, Lanzhou University, Lanzhou 730020, China
[2] School of Economics, Central University of Finance and Economics, Beijing 102206, China
[3] School of Management, Lanzhou University, Lanzhou 730020, China
* Correspondence: fanyb@lzu.edu.cn

Abstract: Under the condition of different endowment factors of herders and imperfect market mechanisms, grassland transfer can promote the redistribution and rational utilization of grassland resources, which has a crucial impact on herders' livelihood. This study fully examined how the grassland rental market improves herders' income and to what extent, using unbalanced panel data with 560 herder households in the Qinghai–Tibet Plateau pastoral areas. A fixed effect model was used as the baseline model. The instrumental variable approach and propensity score matching method were utilized to address the endogeneity problem and sample selection bias. Finally, the mediating effect model was used to analyze the path mechanism of grassland transfer in/out on herder income. The results showed that the total household income increased significantly after participating in grassland transfer. Grassland rent-in increased livestock income, and grassland rent-out increased non-livestock income. After correcting for the selection bias, the income effect of grassland transfer became larger. The grassland rent-in increased the livestock income by promoting production investment. Grassland rent-out increased the non-livestock income by promoting non-pastoral employment.

Keywords: grassland transfer; herder income; PSM; instrumental variable; Qinghai–Tibet plateau

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1. Introduction

Traditionally, grasslands in the pastoral areas of China were jointly owned by all the herders and herders' livestock can graze on the public grasslands. However, since the 1970s, China's grassland has degraded on a large scale, causing severe consequences including forage shortage and ecological degradation [1]. Influenced by Hardin's (1969) "The tragedy of commons" and the tremendous success of the Household Responsibility System in the rural areas since 1978, the Chinese government started to implement the grassland contract management responsibility system in the 1990s. This policy aimed to contract the public grasslands to individual herders to avoid the "tragedy of the commons" and alleviate grassland degradation [2]. The Central Committee of the Communist Party of China's No. 1 Documents from 2008 to 2010 and in 2013 and 2014 clearly stated that grassland should be protected by further improving the grassland contracting system. By the end of 2019, about 73.4% of the grassland in the pastoral areas of China has been contracted [3]. However, such a grassland contracting policy has led to grassland fragmentation and limited nomadic grazing, resulting in misallocation and a waste of grassland resources [4–6].

Moreover, small plots of grassland are not conducive to socialized large-scale production, nor improving production efficiency. Grassland transfer may be an effective means to solve these problems. Many studies have shown that grassland transfer has a significant impact on addressing the problem of grassland fragmentation, transferring surplus labor, optimizing allocation of grassland resources, and improving living quality of herders [7,8].

Thus, it has a positive impact on the economy and ecology of the pastoral areas [6,9]. However, according to the existing research, there is still insufficient evidence to reveal the income effect and its causative mechanism of herders' rent-in and rent-out decisions in the grassland rental market. Elucidating the income effect of grassland transfer is beneficial to guide the standardized and benign development of the grassland rental market.

The main objective of this paper was to provide a more rigorous analysis of the impact of grassland transfer on herders' income. To achieve this goal, this paper used survey data collected from 560 herder households in the Qinghai–Tibet Plateau of China. The Qinghai–Tibet Plateau provides an interesting case because it is the largest pastoral area in China, which accounts for 41.88% of the country's total grassland area [10]. Our study attempts to contribute to the existing literature in three ways. First, we used different models to estimate the income effects of grassland transfer. A fixed effect model was used as the baseline model to examine the impact of grassland transfer on herders' income. The IV regression and propensity score matching (PSM) method were employed to deal with endogeneity problem and selection bias. This can help obtain rigorous estimation of income effect and its causative mechanism of grassland transfer. Second, we investigated the effects of grassland transfer on income of different types, i.e., total income, livestock income, and non-livestock income. Furthermore, different effects between herders' rent-in and rent-out behaviors were analyzed. This can help provide a comprehensive understanding on the effects of grassland transfer on herders' income. Third, this study further employed mediation effect model to explore the intermediate mechanism of grassland rent-in and grassland rent-out that affected herder income. To the best of our knowledge, no empirical research has investigated such intermediate mechanism. Our study could fill this research gap.

The paper was structured as follows: Section 2 specifies literature review and a theoretical framework to delineate the current grassland rental market. Section 3 introduces the study and data. Section 4 details the estimation models and strategies. Section 5 presents the empirical results and discussion. Section 6 concludes the paper with policy implications.

2. Literature Review

The existing literature shows that the driving factors of the grassland rental market at the herder level are mainly based on the following aspects: first, the main characteristic factors of herders reflect their ability to raise livestock and farming, including the basic information of households such as the head's age, education level, gender, and so on [11]. This suggests that herders with higher production and management capabilities represented by age and education level tend to participate more in the grassland rental market. Second, herder household resource endowments and their combination include labor force, grassland area, number of livestock, household income, and production assets [12,13]. For example, herder households with more grassland tend to rent out but not to rent in grassland. In contrast, the households with more labor (representing labor availability) tend to rent in but not rent out grassland. Livestock of household (representing herder ability) show similar patterns. Third, the related grassland and environment policy that encourages or discourages herders to participate in the grassland rental market include grassland ecological compensation and award policy, such as grazing ban and livestock-forage balance [14]. Herder households with more grassland ecological subsidies tend to participate in grassland transfer. This suggests that herder households tend to equilibrate their resource endowments by transferring grassland and keeping livelihood and livestock production balanced. In the case of an imperfect market for non-grassland factors, in order to maintain a high capacity, herders would balance their resources by renting out when there is surplus and renting in when grassland is scarce, avoiding sunk costs caused by excess assets. In addition, household farming capacity also plays a crucial role in land rental market participation.

Studies on land transfer are abundant worldwide. For example, Zhllima et al. (2021) studied agriculture land markets in Albania and found that land transactions occurred mainly in the rental market, dominated by short-term informal agreements [15]. With the

process of disorderly and incomplete land transfer, land acquisition had shown to be an important factor affecting farmers' decision-making on land transactions. Bradfield et al. (2020) proposed that land rental agreements assisted farms in achieving economies of scale in the Republic of Ireland [16]. Perry et al. (2001) found that land transactions typically involve substantial personal interaction between buyer and seller in Oregon, USA, with transactions between relatives and neighbors more frequent than between strangers and acquaintances [17]. Rahman et al. (2009) analyzed the impact of land fragmentation and resource ownership on productivity and technical efficiency in rice production in Bangladesh [18]. Results indicated that land fragmentation had a significant detrimental effect on productivity and efficiency. Niroula et al. (2005) found that the fragmentation of small landholdings and tiny land parcels were detrimental to land conservation and economic returns, thereby discouraging farmers from adopting agricultural innovations in South Asia [19]. Deininger et al. (2003) used data from Nicaragua to examine the performance of land rental and proposed that in order to promote equity and efficiency, liberalization of land sales markets had to be complemented by the measures to reduce attractiveness of speculative land accumulation [20]. Teklu et al. (2004) argued that informal land markets provide a vehicle to balance factor proportions at the farm level and to improve productivity and household welfare in rural Ethiopia [21]. Rahman (2010) studied the socio-economic factors underlying farmers' decision to rent in land and/or rent out land in the land rental market in Bangladesh and proposed that some socio-economic factors influenced farmers' participation in the land rental market [22]. Jin et al. (2013) used panel data from Kenya smallholder households, and they found that Kenya's land rental markets increased farm productivity and significantly raised the incomes of land-constrained farmers [23].

2.1. Drivers of Grassland Rent-In

Among the above-mentioned driving factors, the mismatch and failures of equilibrating the resource endowment of herder households are the major driving forces of grassland rental participation. For the driving factors of grassland rent-in, this paper attributes to moderate-scale management and production investment.

Moderate scale management: the transfer of scattered patches of grassland is beneficial for large-scale operations [24,25]. Some collective economic organizations and large-scale herders can rent grasslands to achieve unified management and effective zoning and rotation grazing, so that that scattered grasslands can be gathered and used, which plays a critical role in reducing grassland fragmentation.

Production and management investment: the investment in fixed assets, such as agricultural machinery and agricultural technology, has promoted the large-scale operation of farmland, which promotes grassland rent-in [26]. Expectations of investment in the grassland also push the transfer-in households to expand their land operations [27]. Similarly, herder households' productive assets increase their participation likelihood of grassland rent-in [6].

2.2. Drivers of Grassland Rent-Out

The driving factors of grassland rent-out are mainly summarized as labor transfer and reorganization of production factors.

Labor transfer: due to the acceleration of urbanization, some herders who were used to nomadic life have resettled in fixed living areas and concentrated in small towns to raise livestock by feeding with grains, which resulted in a surplus of labor, and part of grassland are left idle. The surplus labor may turn to other non-pastoral production operations, so the idle grassland can be rented out. Therefore, grassland rent-out can enable the relocated herders to be engaged in non-pastoral production and obtain more non-livestock income [28,29]. It is also helpful for herders with many non-pastoral employment opportunities to rent out grassland and participate in non-agricultural activities, thereby increasing household income.

Reorganization of production factors: the grassland rental market can better balance and integrate some production factors, such as labor, livestock, and production assets, etc. With the accelerated aging of herders, there is a massive shortage of young and middle-aged labor, and the structure of the labor force has changed in the pastoral areas [30]. Some herder households have a lot of grasslands, but the labor force is insufficient, and the idle grassland can be used rationally by renting out [6,31]. Herder households with more grassland indeed tend to rent in but not rent out land, whereas more household assets encouraged grassland rent-in [32].

2.3. The Influence of Grassland Transfer on Income

The impact of grassland transfer on herders' income is a remarkable concern of the academic community, but many studies have disputed the results. Studies have shown that grassland transfer can increase herders' income and improve their quality of life [32,33]. However, some studies hold different views, arguing that the grassland rental market will increase the gap between the rich and the poor [34]. The reason is that the herders tend to overgraze the rented grassland, which reduces the productivity of these grasslands, that is, the "tragedy of rent-in grassland" [35]. This destroys the subsequent development potential of the grassland and brings significant losses to the poor households. In addition, it is difficult for the low-income herders to change production methods, which makes it challenging to improve their livelihoods, thus leading to the aggravation of the gap between the rich and the poor. A simple theoretical framework of this study is illustrated in Figure 1.

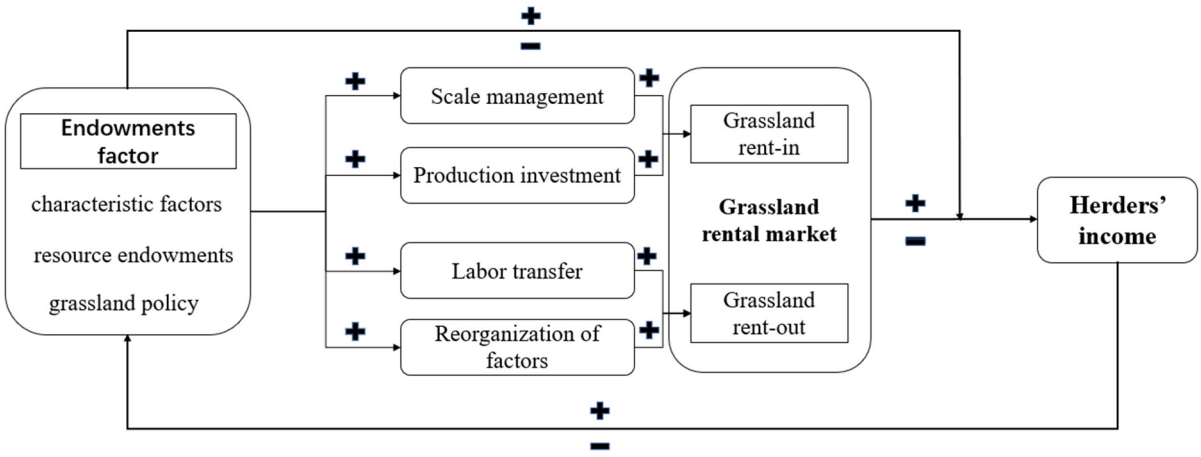

Figure 1. A theoretical framework of this study (The symbols indicate the expected impacts).

The above studies show that participation in the grassland rental market enables herders to better balance resources and affects herders' income. There are at least three crucial research gaps in this field. First, previous studies have failed to explore the endogeneity problem of the income effects of grassland transfer, such as reverse causality and selection bias. Second, previous studies have ignored the different mechanisms between grassland rent-in and grassland rent-out. However, grassland rent-in and grassland rent-out have different impacts on herders' income, which need to be treated differently. Third, previous study areas were concentrated in Inner Mongolia and Xinjiang, and there was no research documenting the Tibetan pastoral areas. Tibet pastoral areas are one of China's eight important pastoral areas and a strong animal husbandry production base.

3. Study Area and Data

3.1. Study Area

This paper focuses on the Qinghai–Tibet Plateau region, including the pastoral areas of Tibet Autonomous Region, Qinghai province, and Gansu province (see Figure 2). As the third pole of the world, the Qinghai–Tibet Plateau is an essential part of the global terrestrial

ecosystem. The grassland area of the Qinghai–Tibet Plateau is the largest among the seven pastoral regions in China, that is, an area of about 165.38 × 104 km^2 [36] accounting for 41.88% of the total grassland area in China and 6% of the world's grassland area [10]. The grassland ecosystem is not only related to the livelihood of local herders but also affects the stability of the entire ecosystem. The sustainable development of grassland resources is directly related to the survival of future generations. Therefore, it is necessary to study the grassland conditions and income effects in the pastoral areas of the Qinghai–Tibet Platea.

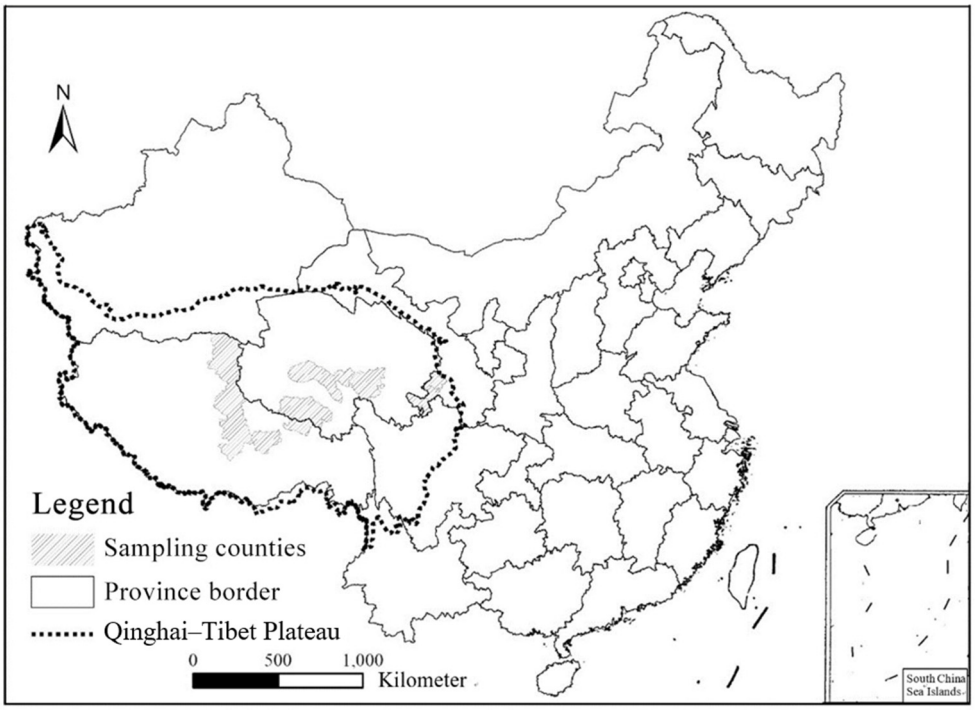

Figure 2. Study area.

3.2. Data

This study used herder household data from the Tibet Autonomous Region, Qinghai Province, and Gansu Province. The herder survey was administered from August to September of 2017, 2018, and 2019. The stratified random sampling method was adopted as follows: First, according to the feasibility of local animal husbandry production and research, nine counties in three provinces were selected, including Nagqu County, Baqing County, and Bangor County in Tibet; Zaduo County, Qumalai County, and Maduo County in Qinghai Province; and Xiahe County, Luque County, and Maqu County in Gansu Province. Secondly, according to the grassland and traffic accessibility, 2–3 towns were randomly selected in each county. About 20 herder households were randomly selected from each town. We obtain some missing data points because some households were absent, and an unbalanced panel dataset with 560 valid questionnaires was obtained. The number of herder households was 209 in 2017, 182 in 2018, and 169 in 2019. The main variables are shown in Table 1.

Table 1. Descriptive statistics of all variables.

Variables	Descriptions	N	Mean	S.D.	Min	Max
Total income	Total household income of herder per year/10,000 yuan	560	8.5275	10.4383	0	104
Livestock income	Livestock income of herder per year/10,000 yuan	560	5.7801	5.8787	0	35.6
Non-livestock income	Non-livestock income of herder per year/10,000 yuan	560	2.7402	8.8775	0	98
Grassland transfer	1 if grassland is transferred, and 0 otherwise	560	0.2232	0.4168	0	1
Grassland rent-out	1 if grassland is rent-out, and 0 otherwise	560	0.0661	0.2486	0	1
Grassland rent-in	1 if grassland is rent-in, and 0 otherwise	560	0.1679	0.3741	0	1
Age	Age of household head/in years	560	50.6875	13.2289	20	88
Gender	1 if a herder is male, and 0 otherwise	560	0.9625	0.1902	0	1
Education	Years of schooling of head/in years	560	1.2286	0.5591	1	5
Labor	Number of labor employed by animal rearing	560	3.7750	1.8062	0	10
Grassland area	Grassland area of household/$\times 10^3$ mu	560	4.4749	7.8009	0	120
Officials	Number of the public officials of household	560	0.2000	0.4468	0	3
Herder_time	Time to engage in animal husbandry/month	560	17.9116	16.9194	0	90
Herder_mode	1 = grazing, 2 = stabling, 3 = mix or others	560	1.6375	0.6406	1	3
Fixed assets	The value of the feeding shed/is 10,000 yuan	560	14.6990	20.7568	0	208.7
No. of vehicles	Number of vehicles	560	1.9411	1.3568	0	8
Plot	The number of grassland plots	560	1.5946	0.6566	1	4
Policy	Grassland-related policies/10,000 yuan	560	0.9878	1.5478	0	21
Non-pastoral employment	Non-agricultural labor force/total household labor force	560	0.4501	0.3100	0	1
Investment	Investments in the production and management/10,000 yuan.	560	14.3456	18.5596	0	100.48

4. Model Specification

The endogeneity problem of this study was due to several issues: first, due to the research design limitations, there may be omitted variable bias. Second, the income level of herders affects whether they participate in grassland transfer, and the decision of grassland transfer will also affect the herders' income. There is a reverse-causality problem. Third, whether herders participate in grassland transfer is a self-selection problem. Herders with a higher income, more labor, and a larger grassland area are more willing to participate in grassland transfer. In contrast, the low-income and small grassland areas of herders are unwilling to participate in grassland transfer. For these problems, this paper mainly solved endogenous problems from the following aspects. First, we used the data on whether the herders in different regions participated in grassland transfer as the core explanatory variables along with as many relevant control variables as possible. We solved the problem of missing variables at the regional level through regional fixed effects. Secondly, for the self-selection problem, this paper used the PSM method to construct a counterfactual framework to explain this problem. Finally, for the problem of reverse causality, this study attempted to use instrumental variable regression to explain the effect of endogeneity on the regression results.

The basic idea of this section is as follows: we first set up a baseline regression to observe the effect of grassland transfer on herders' income. Because we used panel data, in order to solve the problem of missing variables, a fixed effect model was adopted. Second, considering the problem of reverse-causality, we used an instrumental variable regression as a test to observe the existence and impact of endogeneity. Third, because of the self-selection bias mentioned above, we used the most effective PSM method to solve this problem. Finally, after obtaining the estimation results, we realized the influence of grassland transfer on income may be through some intermediate channels, so we did a mechanism test that used the mediation effect model to analyze the internal mechanism.

4.1. Fixed-Effect Model

A fixed-effect model was used to examine the impact of grassland transfer on income. We estimated the following econometric model:

$$lnIncome_{it} = \beta_0 + \beta_1 \cdot Rent_{it} + \beta_2 \cdot X + w_i + u_i + \sigma_i + \varepsilon_{it} \quad (1)$$

where i represents the ith herder; t represents the tth year; w_i is the regional fixed effect; u_i is the year fixed effect; and σ_i is the individual fixed effect. β_0 is a constant term, and β_1 and β_2 are the coefficients to be estimated. ε_{it} is an error term.

In the fixed effect regression model (1), we used the total household income, livestock income, and non-livestock income as the explained variables to do three regressions, respectively. In order to investigate the effects of total household income, livestock income and non-livestock income on herders' participation in grassland transfer, the results were investigated separately. Dependent variable: $lnIncome_{it}$ is the dependent variable, which represents the logarithm of the total household income of herder i in year t. Referring to previous research, this paper considered total household income, livestock income, and non-livestock income [37,38].

Independent variable: $Rent_{it}$ is the explanatory variable, which indicates the participation of herder i in grassland transfer in year t. According to the research problem, it is divided into grassland rent-in and grassland rent-out. However, in our fixed-effect model, the $Rent_{it}$ variable refers to the herders' participation in grassland transfer as a whole, including grassland rent-in and grassland rent-out. β_1 in the model specification is the coefficient to be estimated, indicating the impact of participation in grassland transfer on household income. If β_1 is positive, it means that participation in grassland transfer promotes household income; if β_1 is negative, it means that participation in grassland transfer has a crowding-out effect on household income.

Control variable: X represents the control variables. The selection of control variables was based on the existing relevant literature [39], and considering data availability in the pastoral areas of the Qinghai–Tibet Plateau. This paper also selected other factors that affect the household income of herders. The individual characteristics included herder age (age), gender (gen) and education level (edu). The resource endowment of herder household included the number of labors (labor), t grassland area (grassland), the number of grassland plots (plot), the time to engage in animal husbandry (herder_time), the management mode of animal husbandry (herder_mode), and the public officials of herder household (official), and the value of the feeding shed (fixed assets). Finally, the grassland-related policies (policy) were used to reflect the grassland ecological compensation and reward policy that showed a direct impact on the production and life of herder household.

4.2. Instrumental Variable (IV) Method

According to the requirements of instrumental variables, the selection of IV in this paper must meet the following two conditions: (1) it is related to the decision-making of herders to participate in grassland transfer; (2) it does not directly affect the herders' income through other means.

The instrumental variable selected in this paper is the transfer rate at the village level (Village_level transfer). The herders' willingness to transfer is related to the transfer rate at the village level but is often not directly related to the income of the individual herder, which is an appropriate IV because a herder's decision to rent-in or rent-out grassland is influenced by the village-level transfer rate due to peer effect.

We estimated an instrumental variable (IV) model using two-stage least squares (2SLS) [40]. The IV one-stage model is set as follows:

$$Rent_{it} = \alpha_0 + \gamma_1 \cdot rent\_village + \gamma_2 \cdot X + w_i + u_i + \sigma_i + \varepsilon_{it} \quad (2)$$

where $Rent_{it}$ is the grassland transfer, which refers to the herders' participation in grassland transfer as a whole, including grassland rent-in and grassland rent-out; $rent\_village$ is the

instrumental variable in this study; X represents the control variables; w_i is the regional fixed effect; u_i is the year fixed effect; σ_i is the individual fixed effect. α_0 is a constant term. γ_1 and γ_2 are the coefficients to be estimated. ε_{it} is an error term. The dependent variables and independent variables of the IV two-stage model were consistent with the baseline model (fixed-effects model (1)).

4.3. Propensity Score Matching (PSM) Method

As we mentioned earlier in the endogeneity problem, there is a self-selection problem in grassland transfer, but our baseline regression (fixed-effect model) can only solve the omitted variables, while failing to solve the self-selection bias. So in this section, we used PSM to address self-selection bias. According to the counterfactual framework proposed by Rubin (1974) [41], the non-random data were approximately randomized. The PSM method was used to estimate the counterfactual probability of participating in grassland transfer to deal with the self-selection bias. The basic idea was to find a control group with similar characteristics to the herders who participated in the grassland transfer among the herders who did not participate in the grassland transfer.

First, we constructed a framework to estimate the income effect of grassland transfer. The model constructed in this paper can be presented as follows:

$$lnY_{ij} = \alpha_1 + \alpha_2 X_i + \alpha_3 D_i + \varepsilon_i \quad (3)$$

where Y_{ij} represents the j-th income of herder i. In this paper, j can be expressed as the total family income, livestock income and non-livestock income. D_i represents whether the herder participated in the grassland transfer. If the herder participated in the grassland transfer $D_i = 1$; otherwise, $D_i = 0$. X_i is the control variable, and ε_i is the random disturbance term.

Second, we used the logit regression model to estimate the propensity score (probability of their participation in the grassland transfer) for all the observations, including the participated herders and non-participated herders. The model can be specified as:

$$P(D_i = 1|X_i) = E(D_i = 0|X_i) \quad (4)$$

where $D_i = 1$ indicates the herders participating in grassland circulation (treatment group), and $D_i = 0$ indicates the herders who did not participate in grassland circulation (control group). X_i indicates the matched control variable.

Third, we created matched samples (the treatment and control groups) using propensity scores. Several methods for matching exist. Commonly used matching methods include K-nearest neighbor matching, caliper matching, and kernel matching. After matching, we obtained some matched pairs with one observation from the treatment group (participated in grassland transfer) and one observation from the control group (not participated in grassland transfer).

Finally, the average treatment effect (ATT) of grassland transfer can be obtained by calculating the income difference between the treatment group (participants in grassland transfer) and the control group (non-participants in grassland transfer).

4.4. Mediation Model

From the perspective of literature in Section 2, grassland rent-out has a labor transfer effect, which helps herders with a few non-pastoral employment opportunities. Still, strong livestock production capacity allows some herders to rent in grassland and expand the scale of grassland management. It is also helpful for farmers with many non-agricultural employment opportunities but weak agricultural production ability to rent out land and participate in non-agricultural activities. Thereby, grassland transfer increases the income of these two types of farmers. The land transfer enables more farmers to achieve non-agricultural employment (including migrant workers and self-employed businesses), thereby increasing their income levels [42]. The grassland rent-in has the effect of the production and

management investment effect, which means that the grassland rent-in may affect the herders' income through the intermediary transmission of production investment.

In order to explore the mechanism effects of grassland rent-in and rent-out on income, respectively. The mediation effect model is employed to analyze the influence of the intermediate mechanism of grassland transfer. The mediation model can be specified as follows [43]:

$$Y = cX + e_1 \tag{5}$$

$$M = aX + e_2 \tag{6}$$

$$Y = c'X + bM + e_3 \tag{7}$$

where c is the total effect of X on Y; c' is the direct effect of X on Y after controlling the effect of mediating variable M. The mediating effect is equal to the indirect effect, which is equal to the product of the coefficients, i.e., ab.

To examine the mediating mechanism on the impact of grassland rent-in on livestock income. We constructed the following mediation model:

$$livesstock\_income_i = \alpha_0 + \alpha_1 rent\_in_i + \alpha_2 X_i + \varepsilon_i \tag{8}$$

$$investment_i = \beta_0 + \beta_1 rent\_in_i + \beta_2 X_i + \delta_i \tag{9}$$

$$livestock\_income_i = \gamma_0 + \gamma_1 rent\_in_i + \gamma_2 investment_i + \gamma_3 X_i + \mu_i \tag{10}$$

where $livestock\_income_i$ is household livestock income; $rent\_in_i$ is grassland rent-in; $investment_i$ is the investment in production and management; X_i represents the control variables; ε_i, δ_i, μ_i are error terms. γ_1 measures the direct effect of grassland rent-in on households' livestock income. α_1 measures the total effect of grassland rent-in on the livestock income. $\beta_1\gamma_2$ measures the mediating effect of grassland rent-in on the livestock income through animal husbandry investment. In order to measure the interpretation rate of the intermediary variable, this paper used the coefficient difference method [44], and the expression of the interpretation rate is $\frac{\beta_1\gamma_2}{\alpha_1}$.

Similarly, to examine the mediating mechanism on the impact of grassland rent-out on the non-livestock income. The model can be specified as follows:

$$nonlivestock\_income_i = \alpha_3 + \alpha_4 rent\_out_i + \alpha_5 Z_i + \omega_i \tag{11}$$

$$non\_pastoral\ employment_i = \beta_3 + \beta_4 rent\_out_i + \beta_5 Z_i + \upsilon_i \tag{12}$$

$$nonlivestock\_income_i = \gamma_4 + \gamma_5 rent\_out_i + \gamma_6 non\_pastoral\ employment_i + \gamma_7 Z_i + \xi_i \tag{13}$$

where $nonlivestock\_income_i$ is the non-livestock income, and $rent\_out_i$ is grassland rent-out. $non\_pastoral\ employment_i$ represents the herder household's non-pastoral employment that measures the non-agricultural allocation of the household. This study refers to the research of Qian et al. (2016) [45] and this variable is represented by non-agricultural labor force/total household labor force to represent. Z_i represents the control variables, and ω_i, υ_i, ξ_i are the error terms. In the model, α_4 measures the total effect of grassland rent-out on the non-livestock income; γ_5 measures the direct effect of grassland rent-out on the non-livestock income; $\beta_4\gamma_6$ measures the mediating effect of grassland rent-out on the non-livestock income through non-pastoral employment. In order to measure the interpretation rate of the intermediary variable, we used the coefficient difference method, and the expression of the interpretation rate is $\frac{\beta_4\gamma_6}{\alpha_4}$.

5. Result and Discussion

5.1. Fixed Effects Model Results

This section used a fixed-effect model to estimate the impact of grassland transfer on household income. Table 2 reports the regression results of the fixed-effects model of grassland transfer on household income. Column (1) takes the total household income as

the dependent variable. Grassland transfer has a positive and significant effect on total household income ($p < 0.01$), indicating that a 1% increase in the participation of grassland transfer will significantly increase the total herder household income by 24.41%. The finding is highly relevant to policymakers and is consistent with those of Zhang et al. (2019) and Ke et al. (2022) [46,47]. Column (2) shows the regression results using livestock income as the dependent variable, indicating that grassland transfer has no significant impact on livestock income. Column (3) shows the regression results of non-livestock income, indicating that grassland transfer has no significant impact on non-livestock income.

Table 2. The impact of grassland transfer on household income.

	(1) *Log* Total Income	(2) *Log* Livestock Income	(3) *Log* Non-Livestock Income
Grassland transfer	0.2441 ***	0.0873	0.0824
	(0.0824)	(0.0932)	(0.1915)
Grassland area	0.0038	0.0067	0.0256 **
	(0.0046)	(0.0057)	(0.0099)
Plots	−0.0872	−0.3031 ***	0.0790
	(0.0643)	(0.0929)	(0.1131)
Policy	0.1298 ***	0.1719 ***	0.0704 *
	(0.0332)	(0.0433)	(0.0366)
Age	−0.0001	−0.0023	0.0003
	(0.0028)	(0.0034)	(0.0057)
Education	0.0724	0.0336	0.0907
	(0.0587)	(0.0700)	(0.1277)
Labors	0.0134	0.0326	−0.0281
	(0.0282)	(0.0324)	(0.0500)
Header_way	−0.0011	0.0051 **	−0.0140 ***
	(0.0018)	(0.0025)	(0.0044)
Header_mode	−0.0648	−0.1316 **	0.1662
	(0.0615)	(0.0635)	(0.1225)
Fixed assets	0.0084 ***	0.0014	0.0174 ***
	(0.0022)	(0.0027)	(0.0038)
Officials	0.2559 ***	0.0277	0.8820 ***
	(0.0889)	(0.1117)	(0.1694)
Gender	0.1878	−0.0358	0.2721
	(0.1866)	(0.1838)	(0.3496)
Vehicles	0.1863 ***	0.2519 ***	0.0345
	(0.0353)	(0.0419)	(0.0659)
Time fixed effects	Yes	Yes	Yes
Regional fixed effects	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes
Constant	73.9019	−41.8871	−195.156
	(95.5469)	(122.9845)	(201.8444)
No. of observations	556	550	464
R^2	0.2751	0.3328	0.1415

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The heteroscedastic robust standard errors are in parentheses.

The estimation results of the control variables show that the grassland area has a significant positive effect on the non-livestock income ($p < 0.05$). The possible reason is that after the grassland is transferred out, rental income is generated. Therefore, the herder who rents out more grassland areas is more likely to obtain more rental income. The number of grassland plots has a negative impact on livestock income ($p < 0.01$). Grassland ecological policy has a significant positive impact on total income ($p < 0.01$), livestock income ($p < 0.01$), and non-livestock income ($p < 0.1$) because grassland subsidy is a direct compensation income [48]. The time engaged in animal husbandry has a significant positive impact on livestock income ($p < 0.05$) and a significant negative impact on non-livestock income ($p < 0.01$), which is in line with the finding of Birthal et al. (2017) [49]. Fixed assets, such as sheds and pens, have a significant positive impact on total income ($p < 0.01$) and non-

livestock income ($p < 0.01$). These results suggest that more considerable fixed assets could increase household income [50]. The number of government employees has a significant positive impact on total income ($p < 0.01$) and non-livestock income ($p < 0.01$). The number of transport vehicles has a significant positive effect on total income ($p < 0.01$) and livestock income ($p < 0.01$).

5.2. Instrumental Variable (IV) Method Results

Since there may be problems such as reverse causality, measurement error, and time-variant omitted variables in the fixed-effects model, this study further adopted the grassland transfer rate at the village level (denoted by village-level transfer) as an IV for grassland transfer. Equation (2) was regressed, and the results are shown in Table 3. Parts A and B report the two-stage and one-stage regression results of IV regression, respectively.

Table 3. Estimated results of instrument variable regression.

	(1) ***Log* Total Income**	**(2)** ***Log* Livestock Income**	**(3)** ***Log* Non-Livestock Income**
A: Second stage of 2SLS			
Grassland transfer	0.5475 *	0.7131 *	−1.0015 *
	(0.3180)	(0.4243)	(0.5893)
Grassland area	0.0034	0.0060	0.0266 ***
	(0.0051)	(0.0067)	(0.0102)
Plots	−0.0680	−0.2627 ***	0.0444
	(0.0662)	(0.1003)	(0.1155)
Policy	0.1235 ***	0.1593 ***	0.0955 **
	(0.0340)	(0.0446)	(0.0382)
Age	0.0006	−0.0009	−0.0018
	(0.0028)	(0.0037)	(0.0059)
Education	0.0644	0.0179	0.1298
	(0.0592)	(0.0712)	(0.1390)
Labors	0.0153	0.0364	−0.0309
	(0.0280)	(0.0331)	(0.0517)
Header_way	−0.0008	0.0057 **	−0.0155 ***
	(0.0019)	(0.0026)	(0.0046)
Header_mode	−0.7000	−0.1423 **	0.2043 *
	(0.0614)	(0.0656)	(0.1226)
Fixed assets	0.0081 ***	0.0008	0.0190 ***
	(0.0021)	(0.0029)	(0.0043)
Officials	0.2785 ***	0.0726	0.8099 ***
	(0.0908)	(0.1174)	(0.1801)
Gender	0.1895	−0.0334	0.2967
	(0.1860)	(0.1850)	(0.3686)
Vehicles	0.1756	0.2300 ***	0.0700
	(0.0374)	(0.0431)	(0.0696)
Time fixed effects	Yes	Yes	Yes
Regional fixed effects	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes
Constant	556	550	464
No. of observations	0.2621	0.2995	0.0867
B: First stage of 2SLS			
Village_level transfer	0.9988 ***	0.9950 ***	1.0655 ***
	(0.1424)	(0.1436)	(0.1500)
F value	13.53	13.48	10.50

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The heteroscedastic robust standard errors are in parentheses.

For the results of the one-stage regression (Part B), there is a significant positive correlation ($p < 0.01$) between the Village_level transfer and the grassland transfer of the herders, indicating that the higher the grassland transfer rate at the village level, the more likely the grassland transfer of the herders. At the same time, the F statistic of the one-stage

regression is significantly higher than the critical value level of 1%, indicating that the instrumental variable is not weak.

For convenience, we interpreted the results of the 2SLS model that corrected for the endogeneity problem. For the second stage (Part A), the impact of grassland transfer on total household income is significantly positive ($p < 0.1$), the impact of grassland transfer on livestock income is significantly positive ($p < 0.1$), and the impact on non-livestock income is significantly negative ($p < 0.1$). These results suggest that greater participation in grassland transfer could increase total household income and livestock but decrease non-livestock income, which is consistent with previous findings [44,51]. After using the instrumental variables, the absolute value of the grassland transfer coefficient becomes larger than the estimated coefficient of the fixed effect model, indicating that the regression result of the fixed effect model may be underestimated due to endogeneity problems. It also shows that there may be unobservable factors in Equation (1) that have a negative impact on grassland transfer and household income. For example, reducing the household labor force and the aging may lead to an increase in grassland transfer, but the total household income will decrease. The estimated results of other control variables are consistent with the results of the fixed-effects model regression, except that the coefficients have slightly different values, and their significance and direction of action are consistent. According to the regression results in Tables 2 and 3, it shows the impact of grassland transfer on household income is mainly manifested as an increase in livestock income and squeeze out of non-livestock income (i.e., crowding out effect).

In order to ensure the reliability of the IV regression, this paper adopts the trimmed and winsorized means (the tail processing is carried out on the samples above and below 1% of all continuous variables to reduce the influence of extreme values) for robustness test. The test results are shown in Table 4. It shows Village_level transfer is significant in affecting total income ($p < 0.01$), livestock income ($p < 0.01$), and non-livestock income ($p < 0.01$), and the F value is greater than 10. All these results demonstrate that the instrument variable is valid. Grassland transfer has a positive and significant influence ($p < 0.05$) on total income, and grassland transfer has a positive and significant effect ($p < 0.05$) on livestock income. Grassland transfer has a negative and significant impact ($p < 0.1$) on non-livestock income.

Table 4. Robustness test of instrumental variable regression.

	(1) ***Log* Total Income**	**(2)** ***Log* Livestock Income**	**(3)** ***Log* Non-Livestock Income**
A: Second stage of 2SLS			
Grassland transfer	0.6403 **	0.8915 **	−1.1039 *
	(0.3183)	(0.4285)	(0.5907)
Grassland area	0.0029	0.0044	0.0255 ***
	(0.0063)	(0.0089)	(0.0115)
Plots	−0.0818	−0.2637 ***	0.0359
	(0.0636)	(0.1021)	(0.1160)
Policy	0.1674 ***	0.2224 ***	0.1231 **
	(0.0313)	(0.0407)	(0.0627)
Age	0.0007	−0.0009	−0.0021
	(0.0027)	(0.0037)	(0.0059)
Education	0.0523	0.0109	0.1289
	(0.0589)	(0.0727)	(0.1405)
Labors	0.0174	0.0344	−0.0464
	(0.0255)	(0.0345)	(0.0517)
Header_way	−0.0006	0.0059 **	−0.0157 ***
	(0.0020)	(0.0027)	(0.0047)
Header_mode	−0.0395	−0.1281 **	0.2141 *
	(0.0614)	(0.0673)	(0.1226)

Table 4. *Cont.*

	(1) *Log* Total Income	(2) *Log* Livestock Income	(3) *Log* Non-Livestock Income
Fixed assets	0.0088 ***	0.0001	0.0239 ***
	(0.0026)	(0.0034)	(0.0050)
Officials	0.3098 ***	0.1129	0.8397 ***
	(0.0923)	(0.1192)	(0.1903)
Gender	0.1541	−0.0689	0.2636
	(0.1741)	(0.1849)	(0.3675)
Vehicles	0.1626 ***	0.2296 ***	0.0576
	(0.0374)	(0.0440)	(0.0703)
Time fixed effects	Yes	Yes	Yes
Regional fixed effects	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes
Constant	556	550	464
No. of observations	0.2730	0.2864	0.0794
B: First stage of 2SLS			
Village_level transfer	0.9919 ***	0.9873 ***	1.0623 ***
	(0.1446)	(0.1459)	(0.1493)
R^2	0.2774	0.2756	0.2885
F value	12.87	12.83	10.59

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The heteroscedastic robust standard errors are in parentheses.

5.3. Propensity Score Matching (PSM) Method's Results

Due to the possible self-selection problem, this section estimates the PSM results of the impact of grassland transfer on income. This study lists four matching results to verify the robustness of the estimated results and analyzes the average value of the four matching results.

5.3.1. Grassland Rental Market

Table 5 shows that participation in grassland transfer significantly increases the total household income and livestock income. The results obtained by the four matching methods are similar, indicating that the estimation is robust.

Table 5. PSM results of grassland transfer on herder income.

Variables	Matching Method	Treatment Group	Control Group	ATT	The Mean of ATT	S.D.	T
Total income	k-nearest neighbor matching (k = 4)	2.1157	1.6839	0.4318 ***	0.4384	0.1031	4.19
	caliper matching	2.1097	1.6735	0.4362 ***		0.1041	4.19
	Nearest-neighbor matching within the caliper (1:4)	2.1097	1.6690	0.4407 ***		0.0961	4.58
	kernel matching	2.1157	1.6708	0.4449 ***		0.0914	4.87
Livestock income	k-nearest neighbor matching (k = 4)	1.7414	1.2835	0.4579 ***	0.4735	0.1248	3.67
	caliper matching	1.7329	1.2875	0.4454 ***		0.1252	3.56
	Nearest-neighbor matching within the caliper (1:4)	1.7329	1.2556	0.4772 ***		0.11991	3.98
	kernel matching	1.7414	1.2280	0.5133 ***		0.1141	4.50
Non-livestock income	k-nearest neighbor matching (k = 4)	−0.1141	−0.3638	0.2497	0.1922	0.2314	1.08
	caliper matching	−0.0980	−0.3578	0.2599		0.2339	1.11
	Nearest-neighbor matching within the caliper (1:4)	−0.0980	−0.2725	0.1746		0.2224	0.79
	kernel matching	−0.1141	−0.1989	0.0847		0.2107	0.40

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The results show that the means of total income scores for herders with grassland transfer differ from those without grassland transfer. The estimated total income scores range (from 2.1097 to 2.1157) for herders with grassland transfer is generally higher than the income scores (from 1.6690 to 1.6839) for herders without grassland transfer. The mean of ATT is 0.4384 ($p < 0.01$), which means that after matching to eliminate the observable difference between the treatment group and the control group, the total income of the herder with grassland transfer is higher than that of the herders without grassland transfer. The finding is consistent with the conclusion of previous studies [44]. Regarding livestock income, the estimated livestock income scores (from 1.7329 to 17,414) for herders are higher than livestock income (from 1.2280 to 1.2875) for herders without grassland transfer. The mean of ATT is 0.4735 ($p < 0.01$), which implies that herders who participate in grassland transfer will increase their livestock income by about 47.35% compared with those without grassland transfer. It is confirmed that grassland transfer has a significant impact on livestock income and that it can promote large-scale operation, and livestock income has been significantly improved for large-scale herders. This finding further supports the conclusion of Shi et al. (2022) [52]. Similarly, the results are also showed in the study of Bradfield et al. (2020) in the Republic of Ireland [16]. However, regarding non-livestock income, participation in grassland transfer has little effect on herders in the study area. The possible reason is that for pastoral areas, such as Tibet, due to the geographical environment and other factors, engaging in other non-pastoral production activities is greatly restricted, so there are fewer channels for other sources of income.

In order to further delineate the effect of the specific rental market, we considered the effects of grassland rent-in and grassland rent-out, respectively.

5.3.2. Grassland Rent-In

The estimation results shows that grassland rent-in has a significant effect on herders' total income and livestock income but no significant impact on non-livestock income (Table 6). The means of total income scores for herders with grassland rent-in are different from the scores for herders without grassland rent-in. The estimated total income scores range (from 2.1894 to 2.1974) for herders with grassland transfer is generally higher than the income scores (from 1.6431 to 1.6740) for herders without grassland transfer. The ATT of grassland rent-in on total income is 0.5344 ($p < 0.01$). This indicates that the total income of herders with grassland rent-in increased compared with those without grassland rent-in. The result is consistent with Zhang et al. (2019) and Jimoh et al. (2021) [53,54].

In terms of livestock income, the ATT of grassland rent-in is 0.7345 ($p < 0.01$), indicating that the livestock income of the herders with grassland rent-in is 73.45% higher than that of the herder without grassland rent-in. The possible explanation for the above results is that the grassland area became larger due to grassland rent-in, which means that the stocking capacity is higher than before. The large-scale operation increases the livestock income, leading to an increase in the total income. This finding further supports the effect of "moderate scale operation" [25]. For non-livestock income, the ATT is −0.2249, but this result is not significant. The possible reason is that after participating in grassland rent-in, the grassland area of the herders may expand, and the stocking capacity may increase. Compared with other non-pastoral production activities, herders have more comparative advantages in animal husbandry operations. Therefore, herders are more likely to engage in animal husbandry to obtain livestock income rather than in non-pastoral business activities, so there is no directly noticeable impact on non-livestock income.

Table 6. PSM results of grassland rent-in on herder income.

Variables	Matching Method	Treatment Group	Control Group	ATT	Mean of ATT	S.D.	T
Total income	k-nearest neighbor matching (k = 4)	2.1974	1.6630	0.5343 ***	0.5344	0.1034	5.17
	caliper matching	2.1894	1.6740	0.5154 ***		0.1035	4.98
	Nearest-neighbor matching within the caliper (1:4)	2.1894	1.6560	0.5334 ***		0.0950	5.62
	kernel matching	2.1974	1.6431	0.5543 ***		0.0922	6.01
Livestock income	k-nearest neighbor matching (k = 4)	1.9385	1.2144	0.7242 ***	0.7345	0.1251	5.79
	caliper matching	1.9385	1.2161	0.7225 ***		0.1261	5.73
	Nearest-neighbor matching within the caliper (1:4)	1.9385	1.2182	0.7203 ***		0.1190	6.05
	kernel matching	1.9385	1.1675	0.7710 ***		0.1139	6.77
Non-livestock income	k-nearest neighbor matching (k = 4)	−0.4008	−0.2294	−0.1714	−0.2249	0.2681	−0.64
	caliper matching	−0.3775	−0.2332	−0.1442		0.2678	−0.54
	Nearest-neighbor matching within the caliper (1:4)	−0.3775	−0.0966	−0.2808		0.2449	−1.15
	kernel matching	−0.4008	−0.0974	−0.3033		0.2367	−1.28

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.3.3. Grassland Rent-Out

From Table 7, it can be seen that the grassland rent-out has no significant impact on herders' total income and livestock income, but it has a significant positive effect on the increase in non-livestock income. The average treatment effect of grassland rent on non-livestock income was 0.6671 ($p < 0.05$), indicating that after participating in grassland rent-out, herders' non-livestock income increased by 66.71% compared with those without grassland rent-out. A possible explanation is that the herders whose grasslands are transferred out have more opportunities to engage in non-pastoral production activities so that the non-livestock income increases.

Table 7. PSM results of grassland rent-out on herder income.

Variables	Matching Method	Treatment Group	Control Group	ATT	Mean of ATT	S.D.	T
Total income	k-nearest neighbor matching (k = 4)	1.8930	1.9025	−0.0095	0.0661	0.1910	−0.05
	caliper matching	1.9290	1.8711	0.0580		0.1963	0.30
	Nearest-neighbor matching within the caliper (1:4)	1.9290	1.8206	0.1085		0.1810	0.60
	kernel matching	1.8930	1.7853	0.1077		0.1828	0.59
Livestock income	k-nearest neighbor matching (k = 4)	1.2438	1.4532	−0.2094	−0.1768	0.2265	−0.92
	caliper matching	1.2002	1.3766	−0.1764		0.2367	−0.75
	Nearest-neighbor matching within the caliper (1:4)	1.2002	1.3964	−0.1962		0.2186	−0.90
	kernel matching	1.2438	1.3691	−0.1253		0.2149	−0.58
Non-livestock income	k-nearest neighbor matching (k = 4)	0.5885	−0.1428	0.7313 ***	0.6671	0.3374	2.17
	caliper matching	0.6049	−0.1456	0.7505 ***		0.3761	2.02
	Nearest-neighbor matching within the caliper (1:4)	0.6049	−0.0255	0.6304 *		0.3456	1.82
	kernel matching	0.5798	−0.0162	0.5960 **		0.3035	1.96

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The estimation results show that the scores for herders with grassland rent-out are not significantly different from those without grassland transfer. The grassland rent-out has a positive effect on total income, but not significant. A possible explanation is that after the grassland is transferred out, it does not mean that the herders cannot obtain income from the grassland, and the herders will obtain rental income. However, the rental income is lower than the income from direct animal husbandry production so the total income increase is insignificant. Similar results have been found in the existing literature [55].

There is a negative but not significant relationship between grassland rent-out and livestock income, which is consistent with the findings of Li et al. (2019) [56]. The possible reasons are as follows: after the grassland is transferred out, the grassland area becomes smaller, and the livestock capacity decreases. The livestock income mainly depends on grassland, so the livestock income may decrease. However, the number of livestock of the herders participating in the grassland rent-out is relatively small. Therefore, even if the grassland area is reduced, it will not affect the raising of existing livestock to a large extent, so the grassland rent-out will not significantly affect the livestock income.

5.4. Mediation Model Results

From the previous conclusions, grassland rent-in has a significant impact on livestock income, and the grassland rent-out has a significant impact on non-livestock income. In order to explore the influence path, this section constructs a mediation model to explore the mechanism of grassland rent-in in and grassland rent-out.

In this section, we discuss the transmission paths of grassland rent-in affecting livestock income and of grassland rent-out affecting non-livestock income. Grassland rent-in affects livestock income by affecting the productive investment of animal husbandry. Grassland rent-out affects non-livestock income by affecting non-pastoral employment.

Table 8 shows the mediation effect model to estimate the impact path of grassland rent-in on livestock income. The results show that the coefficients are all significant ($\alpha_1 = 3.381$), which indicates that the productive investment of the herders has indeed played an intermediary role in the process of grassland rent-in affecting the herders' livestock income. This conclusion agrees with Qian et al. (2022) [57]. The estimated results show that, for the livestock income, the total explanation rate of the mediating effect of grassland rent-in on livestock income through productive investment is 6.058%.

Table 8. Mediating effect test of grassland rent-in.

Variables	Livestock Income	Investment	Livestock Income
Grassland rent-in	3.381 *** (0.593)	0.236 * (0.141)	3.149 *** (0.603)
Investment	——	——	0.868 *** (0.179)
control variables	Yes	Yes	Yes
Constants	4.9029 *** (1.3884)	1.812 *** (0.348)	3.725 ** (1.455)
R^2	0.2537	0.1057	0.2856
Prob > F	0.0000	0.0000	0.0000
No. of obs	560	538	538
The proportion of indirect effects		6.058%	

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The heteroscedastic robust standard errors are in parentheses. Control variables include: *Grassland area*, *Plots*, *Policy*, *Age*, *Education*, *Labors*, *Header_way*, *Header_mode*, *Fixed assets*, *Officials*, *Gender*, *Vehicles*. Control variables were selected based on the discussion of Sections 2.1 and 2.2.

Table 9 shows the results of using the mediation effect model to estimate the impact path of grassland rent out on non-livestock income. The estimated coefficients are all significant, indicating that non-pastoral employment has indeed played an intermediary role in the grassland rent-out affecting non-livestock income, which implies that grassland rent-out affects non-livestock income by affecting non-pastoral employment. The driving

factor for the grassland rent-out is the labor force transfer, and the lack of labor force in some households will prompt them to rent out their idle grassland. However, most families with scarce labor force are the elderly or relatively poor ones. When the grasslands are transferred out, they cannot easily change their occupations to engage in non-pastoral activities and the non-livestock income only plays a complementary role though its proportion of total income (Yin et al., 2019) [58]. Substantial evidence of poor people's inability to overcome important entry barriers to many non-farm activities (Reardon (2000) [59]. Therefore, grassland rent-out has a negative impact on the non-pastoral employment. However, if the grassland is transferred out, rental income or government relief and subsidy income will be obtained, so it has a positive impact on non-livestock income. The estimated results show that, for the non-livestock income, the total explanation rate of the mediating effect of grassland rent-out through non-pastoral employment on non-livestock income is 11.34%. These results indicate that the coefficients of the variables are slightly different, but the effect and significance level of the variables are consistent with the previous results, which implies that the regression results of this paper are robust, so the conclusions drawn have not changed.

Table 9. Mediating effect test of grassland rent-out.

Variables	Non-Livestock Income	Non-Pastoral Employment	Non-Livestock Income
Grassland rent-out	2.924 ** (1.537)	−0.064 * (0.038)	2.591 * (1.530)
Non-pastoral employment	——	——	−5.180 ** (1.712)
control variables	Yes		
The proportion of indirect effects		11.34%	
Constants	5.372 (3.537)	0.548 *** (0.088)	8.210 ** (3.634)
R^2	0.0925	0.5408	0.1075
Prob > F	0.0000	0.0000	0.0000
No. of obs	560	560	560
The proportion of indirect effects		11.34%	

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The heteroscedastic robust standard errors are in parentheses. Control variables include: *Grassland area*, *Plots*, *Policy*, *Age*, *Education*, *Labors*, *Header_way*, *Header_mode*, *Fixed assets*, *Officials*, *Gender*, *Vehicles*. Control variables were selected based on the discussion of Sections 2.1 and 2.2.

A comparison of the two above estimation results shows that the mediating effect of household non-livestock income is strong, while the mediating effect of livestock income is weak. This is because the grassland rent-out affects the non-pastoral employment of households, and the labor force is released. The most direct impact of non-pastoral employment is the income of households from non-pastoral employment. Therefore, the mediating effect of grassland transfer on non-pastoral income is the strongest.

6. Conclusions and Implications

Grassland is not only an essential component of the ecological environment in the pastoral areas but also a fundamental guarantee for herders' production and life. Under the condition that individuals have different endowment factors and the current market mechanism is not perfect, the grassland rental market plays a vital role in promoting the redistribution and rational utilization of grassland resources. Although some studies have analyzed the relationship between grassland transfer and herders' income, they did not discuss the mechanism of grassland transfer's impact on herders' income, nor considered the problem of selection bias caused by observable and unobservable factors, endogeneity problem, and the intermediate mechanism. Using an unbalanced panel dataset collected from herder households in the pastoral areas of Tibet, Qinghai, and Gansu Province of China, this paper estimated the effects of grassland transfer on household income. The

fixed effect model regression was employed to estimate a baseline regression of grassland transfer on income. An IV regression was used to estimate the endogeneity problem in a baseline regression. The propensity score matching approach was used to match herders with grassland transfer and those without grassland transfer to solve the selection bias issue due to observable factors. The mediation effect model was used to explore the mechanism and path between grassland transfer and herders' income.

The fixed effect model results showed that grassland transfer has a positive and significant impact on herders' total income, and there are significant differences in livestock and non-livestock income. After considering the endogeneity problem, the results of grassland transfer on income may be underestimated. After accounting for selection bias for observable factors, the total income for herders with grassland transfer was found to be positive and significant. In particular, the findings also revealed that for the herders with grassland rent-in, their livestock income was significantly increased, while for herders who participated in grassland rent-out, their non-livestock income was significantly increased. The influence paths were discussed, respectively, and results showed that grassland rent-in affects livestock income by affecting investment in animal husbandry, while grassland rent-out affected non-livestock income by affecting non-pastoral employment.

The findings play an important role in policy implications. First, grassland transfer increases the household income, suggesting that policymakers should standardize the grassland rental market with policy incentives to encourage herders to rent-in or rent-out grassland. Second, grassland rent-in can increase the livestock income, and grassland rent-out can increase non-livestock income, implying that government regulation on grassland transfer could encourage herders who graze small scale or no livestock to rent out their grassland to other herders with more livestock and higher production and management ability so that they can obtain more income. Third, grassland rent-out affects non-livestock income by affecting non-pastoral employment. Therefore, the transfer of labor has promoted the expansion of non-pastoral employment, which plays an essential role in promoting the impact of grassland transfer on income. In addition, government regulations related to the grassland rental market should be further improved, so that can promote the healthy and sustainable development of grassland rental markets.

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References

1. Li, B. The Rangeland Degradation in North China and Its Preventive Strategy. *Zhongguo Nong Ye Ke Xue* **1997**, *6*, 2–10.
2. Li, W.J.; Huntsinger, L. China's Grassland Contract Policy and Its Impacts on Herder Ability to Benefit in Inner Mongolia: Tragic Feedbacks. *Ecol. Soc.* **2011**, *16*, 1. [CrossRef]
3. National Animal Husbandry Service. *China Grassland Statistics 2019*; China Agriculture Press: Beijing, China, 2021.
4. Tan, S.H. Impacts and Mechanisms of Grazing Institutional Transitions on Grassland Degradation. *Issues Agric. Econ.* **2020**, *2*, 115–125.
5. Li, W.J.; Saleem, H.A.; Zhang, Q. Property Rights and Grassland Degradation: A Study of the Xilingol Pasture, Inner Mongolia, China. *J. Environ. Manag.* **2007**, *85*, 461–470.
6. Tan, S.H.; Liu, B.; Zhang, Q.Y.; Zhu, Y.; Yang, J.H.; Fang, X.J. Understanding Grassland Rental Markets and Their Determinants in Eastern Inner Mongolia, PR China. *Land Use Policy* **2017**, *67*, 733–741. [CrossRef]
7. Xu, L.; Wang, L.X. Exploring the Development Path of Grassland Circulation in Pastoral Areas—A Case Study of Yanchi Pastoral Area in Ningxia. *Issues Agric. Econ.* **2011**, *32*, 105–109.

8. Wang, J.; Ju, F. Factors Influencing the Land Transaction Behavior for Farmers in Rural Areas and Pastureland of Inner Mongolia. *J. Arid. Land Resour. Environ.* **2015**, *29*, 74–79.
9. Kemp, D.R.; Han, G.D.; Hou, X.Y.; Zhang, Y.J. Innovative Grassland Management Systems for Environmental and Livelihood Benefits. *Proc. Natl. Acad. Sci. USA* **2013**, *110*, 8369–8374. [CrossRef]
10. Tan, K.; Philippe, C.; Piao, S.L.; Wu, X.P.; Tang, Y.H.; Nicolas, V.; Liang, S.; Fang, J.Y. Application of the ORCHIDEE Global Vegetation Model to Evaluate Biomass and Soil Carbon Stocks of Qinghai-Tibetan Grasslands. *Glob. Biogeochem Cycles* **2010**, *24*. [CrossRef]
11. Tan, Z.C.; Tan, S.H. Grassland Rental Markets and Herders' Technical Efficiency: Ability Effect or Resource Balance Effect? *China Popul. Resour. Environ.* **2018**, *28*, 76–85. [CrossRef]
12. Xu, F.R.; Qiao, G.H.; Hou, A.H. A Comparative Analysis of the Willingness of Land Transfer between Agricultural and Semi-agricultural and Semi-pastoral Areas—A Case Study of Ordos City, Inner Mongolia. *J. Agrotech. Econ.* **2010**, *2*, 24–30.
13. Ding, W.Q.; Yang, Z.R.; Yin, Y.T.; Ma, C.; Hou, X.Y. The Influence of Herdsmen's Livelihood Strategy on the Grassland Management Right Transfer. *J. Arid. Land Resour. Environ.* **2019**, *33*, 31–35.
14. Su, L.F.; Tang, J.J.; Qiu, H.G. Intended and Unintended Environmental Consequences of Grassland Rental in Pastoral China. *J. Environ. Manag.* **2021**, *285*, 112–126. [CrossRef] [PubMed]
15. Zhllima, E.; Rama, K.; Imami, D. Agriculture land markets in transition-The inherited challenge of the post-communist land reform in Albania. *Land Use Policy* **2021**, *107*, 105509. [CrossRef]
16. Bradfield, T.; Butler, R.; Dillon, E.J.; Hennessy, T. The factors influencing the profitability of leased land on dairy farms in Ireland. *Land Use Policy* **2020**, *95*, 104649. [CrossRef]
17. Perry, G.M.; Robison, L.J. Evaluating the Influence of Personal Relationships on Land Sale Prices: A Case Study in Oregon. *Land Econ.* **2001**, *77*, 385–398. [CrossRef]
18. Rahman, S.; Rahman, M. Impact of land fragmentation and resource ownership on productivity and efficiency: The case of rice producers in Bangladesh. *Land Use Policy* **2009**, *26*, 95–103. [CrossRef]
19. Niroula, G.S.; Thapa, G.B. Impacts and causes of land fragmentation, and lessons learned from land consolidation in South Asia. *Land Use Policy* **2005**, *22*, 358–372. [CrossRef]
20. Deininger, K.; Zegarra, E.; Lavadenz, I. Determinants and Impacts of Rural Land Market Activity: Evidence from Nicaragua. *World Dev.* **2003**, *31*, 1385–1404. [CrossRef]
21. Teklu, T.; Lemi, A. Factors affecting entry and intensity in informal rental land markets in Southern Ethiopian highlands. *Agric. Econ.* **2004**, *30*, 117–128. [CrossRef]
22. Rahman, S. Determinants of agricultural land rental market transactions in Bangladesh. *Land Use Policy* **2010**, *27*, 957–964. [CrossRef]
23. Jin, S.; Jayne, T.S. Land Rental Markets in Kenya: Implications for Efficiency, Equity, Household Income, and Poverty. *Land Econ.* **2013**, *89*, 246–271. [CrossRef]
24. Zhang, L.Z. Study on Moderate Scale Management of Grassland Animal Husbandry. *Inq. Into Econ. Issues* **2011**, *12*, 51–56.
25. Zhang, Z.H.; Zhang, X.M. Study on Scale Management of Herdsmen Grassland under Ecological Restriction. *J. Agrotech. Econ.* **2015**, *6*, 82–90.
26. Liu, F.Q. A Study of the Conditions of the Scale Operation of Farmland, and of the Effect thereof: Taking the Northeastern Countryside as a Case. *J. Manag. World* **2006**, *9*, 71–79.
27. Han, J.B.; Zhang, S.F.; Liu, S.Y.; Chang, J.X. Land Entitlement, Land Investment, and Farmer Land Scale Management from an Incomplete Contract Perspective. *Resour. Sci.* **2018**, *40*, 2015–2028.
28. Dickinson, D.; Michael, W. Environmental Resettlement and Development, on the Steppes of Inner Mongolia, PRC. *J. Dev. Stud.* **2007**, *43*, 537–561. [CrossRef]
29. Fan, M.M.; Li, Y.B.; Li, W.J. Solving One Problem by Creating a Bigger One: The Consequences of Ecological Resettlement for Grassland Restoration and Poverty Alleviation in Northwestern China. *Land Use Policy* **2015**, *42*, 124–130. [CrossRef]
30. Xu, C.Y. Research on the Aging of Labor Force in Pastoral Areas Based on the Sustainable Development of Grassland Pastoral Areas. *Mod. Agric. Sci. Technol.* **2017**, *12*, 280–283.
31. Qiao, G.H.; Zhang, B.; Zhang, J.; Colin, B. Land Rental, Prices and the Management of China's Grasslands: The Case of Inner Mongolia Autonomous Region. *Rangel. J.* **2018**, *40*, 231–240.
32. Liu, B.; Tan, S.H. Understanding the Influence of Social Capital on Herder's Grassland Rental Decision. *J. Arid. Land Resour. Environ.* **2018**, *32*, 13–18.
33. Yi, L.Q.; Zhang, Y.F.; Sa, R.L. Impact Factors on Grassland Transfer in West Ujimqin of Inner Mongolia. *China Land Sci.* **2014**, *28*, 20–24+32.
34. Lai, Y.P.; Li, W.J. Pasture Transfer's Impact on Grassland Ecosystem and Pastoralists' Livelihoods in Arid and Semi-arid Area: A Case Study in New Barag Right Banner, Hulunbeir. *Resour. Sci.* **2012**, *34*, 1039–1048.
35. Su, L.F.; Qiu, H.G.; Tang, J.J. The 'Tragedy of Rent-in Grassland' of Grassland Transfer: An Empirical Analysis Based on Survey Data Collected from 876 Plots. *Chin. Rural. Econ.* **2021**, *3*, 68–85.
36. Zhang, L.; Zhou, G.S.; Ji, Y.H.; Bai, Y.F. Spatiotemporal Dynamic Simulation of Grassland Carbon Storage in China. *Sci. Sin.* **2016**, *46*, 1392–1405. [CrossRef]
37. Guo, J.P.; Qu, S.; Xia, Y.; Lv, K.Y. Research on Income Distributive Effects of Farmland Circulation. *China Popul. Resour. Environ.* **2018**, *28*, 160–169.

38. Leng, Z.H.; Fu, C.J.; Xu, X.P. Family Income Structure, Income Gap, and Land Circulation: A Microscopic Analysis Based on CFPS Data. *Econ. Rev.* **2015**, *5*, 111–128.
39. Guan, S.Q.; Li, H.W.; Tang, Z. Key Factors Affecting Herder's Income: A Meta-analysis and Cumulative Meta-analysis. *Cao Ye Xue Bao* **2021**, *30*, 1–15.
40. Wooldridge, J.M. *Introductory Econometrics: A Modern Approach*; South-Western College Pub: Cincinnati, OH, USA, 2012.
41. Rubin, B.D. Estimating causal effects of treatments in randomized and nonrandomized studies. *J. Educ. Psychol.* **1974**, *56*, 688–701. [CrossRef]
42. Chen, B.K.; Ma, N.N.; Wang, D.L. Land Circulation, Agricultural Productivity and Rural Household Income. *J. World Econ.* **2020**, *43*, 97–120.
43. Wen, Z.L.; Ye, B.J. Analyses of Mediating Effects: The Development of Methods and Models. *Adv. Psychol. Sci.* **2014**, *22*, 731–745. [CrossRef]
44. Li, X.D.; Li, L.T.; Su, L.L.; Xia, Y. Analysis on the Income Effect of Herdsmen's Grassland Circulation. *J. Agrotech. Econ.* **2019**, *11*, 104–115.
45. Qian, L.; Hong, M.Y. Non-agricultural Employment, Land Transfer and Agricultural Production Efficiency Change–Empirical Analysis Based on CFPS. *Chin. Rural. Econ.* **2019**, *9*, 58–72.
46. Zhang, M.Y.; Dong, J.J.; Wei, J.N.; Zhang, L.Z. An Empirical Study on the Influence of Grassland Transfer on Households Income. *J. Arid. Land Resour. Environ.* **2019**, *33*, 26–31.
47. Ke, L.; Wang, X.Q.; Chen, D.Q. Farmland Transfer and Farmers' Income Growth: Based on the Perspective of Income Structure. *Chin. J. Popul. Resour. Environ.* **2022**, *32*, 127–137.
48. Hou, L.L.; Xia, F.; Chen, Q.H.; Huang, J.K.; He, Y.; Nathan, R.; Scott, R. Grassland Ecological Compensation Policy in China Improves Grassland Quality and Increases Herders' Income. *Nat. Commun.* **2021**, *12*, 1–12. [CrossRef]
49. Birthal, P.; Negi, D.; Roy, D. *Enhancing Farmers' Income: Who to Target and How? Policy Paper 30*; NIAP: New Delhi, India, 2017.
50. Hua, L.M.; David, M. Herders' Income and Expenditure: Perceptions and Expectations. In *Towards Sustainable Use of Rangelands in North-West China*; Springer: Dordrecht, The Netherlands, 2010; pp. 233–253.
51. Li, X.D.; Mi, Q.; Li, L.T.; Gao, S. Income Increase and Ecological Protection: The Analysis of the Market-Oriented Circulation Mechanism of Double-Guaranteed Grassland. *Ecol. Econ.* **2019**, *35*, 128–132.
52. Shi, Y.X.; Li, C.Q.; Zhao, M.J. The Effect, Mechanism, and Heterogeneity of Grassland Rental on Herders' Livestock Production Technical Efficiency: Evidence from Pastoral Areas in Northern China. *Environ. Dev. Sustain.* **2022**. [CrossRef]
53. Zhang, X.L.; Fan, W.T.; Zhao, Z.Y.; Li, G.M.; Yang, D.Z.; Tang, Z. Analysis of Influencing Factors on Grassland Inflow Behavior of Herdsmen in Qinghai-Tibet Plateau–Based on a Survey of 495 Herdsmen. *Chin. J. Grassl.* **2019**, *41*, 128–133.
54. Jimoh, S.O.; Li, P.; Ding, W.Q.; Hou, X.Y. Socio-Ecological Factors and Risk Perception of Herders Impact Grassland Rent in Inner Mongolia, China. *Rangel. Ecol. Manag.* **2021**, *75*, 68–80. [CrossRef]
55. Qin, C.S.; Wu, Y.Q.; Li, F.N.; Zhou, X.; Tang, Z. The Effects of Grassland Circulation on Herdsmen's Family Income: An Empirical Analysis Based on the Propensity Score Matching Method. *Pratacultural Sci.* **2021**, *38*, 2087–2095.
56. Li, H.; Wang, X.B.; Ren, Y.J. Comparative Analysis of the Mechanism of Mediation Effects–Evidence from Farmers' Income and Health. *J. Agrotech. Econ.* **2019**, *9*, 58–72.
57. Qian, L.; Lu, H.; Gao, Q.; Lu, H.L. Household-owned Farm Machinery vs. Outsourced Machinery Services: The impact of Agricultural Mechanization on the Land Leasing Behavior of Relatively Large-scale Farmers in China. *Land Use Policy* **2022**, *115*, 106008. [CrossRef]
58. Yin, Y.T.; Hou, Y.L.; Colin, L.; Bai, H.H.; Hou, X.Y. Herder Stocking Rate and Household Income under the Grassland Ecological Protection Award Policy in Northern China. *Land Use Policy* **2019**, *82*, 120–129. [CrossRef]
59. Reardon, T.; Taylor, J.E.; Stamoulis, K.; Lanjouw, P.; Balisacan, A. Effects of Non-farm Employment on Rural Income Inequality in Developing Countries: An Investment Perspective. *J. Agric. Econ.* **2000**, *51*, 266–288. [CrossRef]